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VOLUME 73 APRIL, 1955 NUMBER 4

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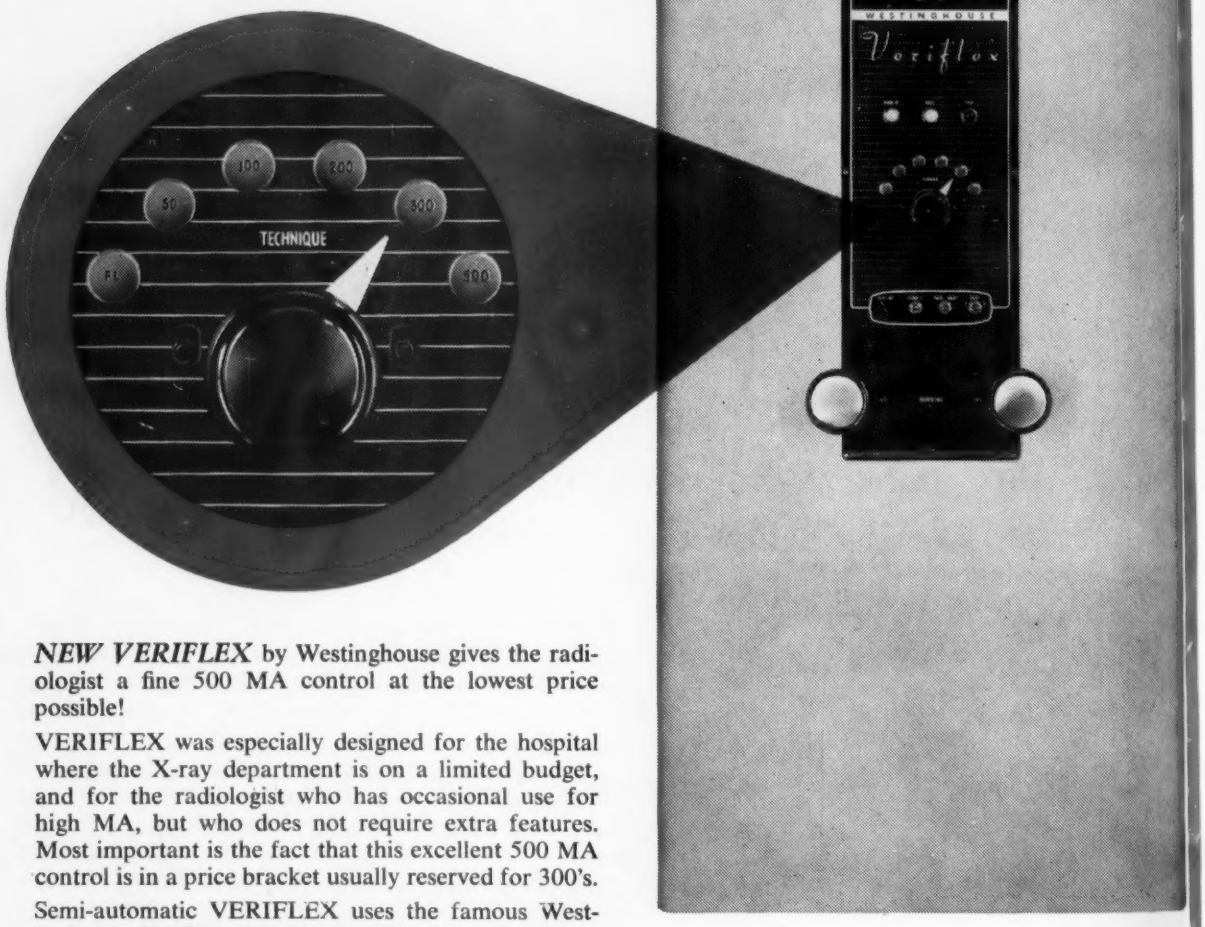

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THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 73 APRIL, 1955 No. 4

TRANSLUMBAR AORTOGRAPHY AS A DIAGNOSTIC PROCEDURE IN UROLOGY*

WITH NOTES ON CAVAL PHLEBOGRAPHY

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INTRODUCTION

THIS study of translumbar aortography was begun in November, 1950, at the instigation of Prof. George F. Cahill who wished first-hand evaluation of the method for diagnosis in urology. Dr. Cahill sent the senior author to Cincinnati to watch Drs. Parke G. Smith and Arthur T. Evans[77,78,79,80] perform the procedure. After having used their technique in our first several cases, we instituted modifications which we consider advantageous: (1) exclusively local procaine anesthesia, except in children; (2) 20 to 40 cc. syringe; (3) gauge 17 needle with a gauge 16 bore (see below); (4) stereoscopic exposures by two separate injections at a widely separated time-interval, made possible by local anesthesia. In collaboration with Prof. Ralph A. Deterling, Jr., we have measured intra-arterial pressures before, during, and after intra-aortic injection. As a result of our study, we consider translumbar aortography safe provided the technique described below is followed. It has proved of value in diagnosis on the Urological Service.

The pathological examinations were done by Dr. M. M. Melicow except for 3 cases which were transferred to Delafield Hospital under the supervision of Prof. Perry B. Hudson.

TECHNIQUE

1. *Preparation and Pre-medication.* Most injections were done in the early afternoon. If the patient had been constipated he was given an effective enema the night before to clear feces from the colon, which could be disconcerting when faint pooling of injected iodide was being sought. The follow-

* Work carried out while the senior author was Resident in Urology at the Columbia-Presbyterian Hospital, New York, New York,

ing morning he received a light breakfast and all oral intake was withheld after 9 a.m. At noon he received 200 mg. sodium luminal subcutaneously and was sent on a litter to the roentgenography unit one hour later with a syringe containing 100 mg. demerol. After he was centered on the roentgenographic table in the prone position he was given a test dose of 0.25 cc. 75 per cent neo-iopax or 70 per cent urokon, depending upon which was to be used, through a No. 26 "hypodermic" needle, into an arm or hand vein, and, through the same needle, the 100 mg. demerol was injected intravenously. Intravenous administration of the test dose has the advantages of speed and, at least empirically, reliability judging from the thousands of cases submitted to intravenous urography in the Department of Urology where a test dose is injected and then the remainder after a wait of at least one minute (*cf.* also Armbruster and Hefke, 1952).

In aortography the interval between the test dose and the intra-aortic injection has been over five minutes because of the wait for development of the survey roentgenogram of the abdomen with the aortographic needle through the body wall. The intradermal and intraocular routes for sensitivity testing are known to yield equivocal results (Archer and Harris, 1942; Naterman and Robins, 1942; Robins, 1942; Alyea and Haines, 1947; Singer, 1948; Narath, 1951).

The patient's back is then cleansed with tincture of zephiran 1:1,000 and a sterile towel is placed over his back and another over his buttocks leaving exposed the area to be manipulated.

2. *Anesthesia and Intra-aortic Injection.* The first 14 cases were done under intravenous pentothal anesthesia. The anesthetists disliked giving pentothal to an unintubated patient in the prone position. One patient had severe laryngeal spasm before the iodide was injected and another patient immediately after he was turned on the litter from the roentgenographic table. The anesthetists therefore suggested spinal anesthesia, which was given in 2 cases with the patient prone. In the second case (PH 736644) the cutaneous anesthesia extended only as high as dermatome L_2 posteriorly but the aortic puncture was performed at T_{12}. The patient, a nervous hypochondriacal woman, nevertheless felt only a not unpleasant fleeting warmth extending through her abdomen toward the rectum immediately after the rapid injection of 20 cc. of 75 per cent neo-iopax. For the next few days she had a severe "spinal" headache whenever she lifted her head from the horizontal. Cognizant that the aorta had not been anesthetized at the level of the intra-aortic injection, we chose a phlegmatic elderly male (PH 972335) for our first attempt at intra-aortic injection of 75 per cent neo-iopax under exclusively local anesthesia. The result was so satisfactory that we have done all subsequent injections (about 200) under local anesthesia except for the 2 children, ten and twelve and a half years old. Our last many aortograms have been done with 70 per cent urokon, all under local anesthesia, and we have found this iodide more tolerable (see below).

We performed our first aortogram under local anesthesia on March 1, 1951, our work being mentioned before the Society for Vascular Surgery in June, 1951 (*cf.* Deterling, 1952). Before us, Doss *et al.* (1942), Ducuing *et al.* (1949) and Gadermann and Schrader (1951) had used 70 per cent diodrast for aortography under local anesthesia. Melick *et al.* (1952) and Nesbit and Nesbitt (1952) are doing aortography under local anesthesia using 70 per cent urokon. Dos Santos (1929) and Osorio (1933) preferred spinal to general anesthesia for aortography because the latter does not permit voluntary control of breathing. Being able to cease breathing at a given signal is an advantage of local anesthesia.

The patient is informed of all steps that are about to be taken, to allay his anxiety. The lowermost palpable left rib, the eleventh or twelfth, is felt by proceeding cephalad from the iliac crest. A twelfth rib of 5 cm. or less in length is usually not palpable. The fingers are run medially along

the rib until its intersection by the erector spinae muscles, medial to which it usually cannot be felt. The line of the rib is subtended to the spinal column and a No. 26 hypodermic needle is inserted into the skin at this point as a landmark. An intradermal wheal with 0.5 per cent procaine is made directly caudad to the lowermost rib about a palm's breadth to the left of the spinous processes, *i.e.*, typically 9 cm. The subcutaneous tissues are infiltrated with 0.5 per cent procaine, through a No. 21 or 3 inch needle, toward the tip of the No. 26 needle which is presumably over T_{12}. The inclination of penetration of the aortographic needle will be gained by experience; it approximates 45° but it is preferable for the beginner to be shallow rather than too deep. When bone has been struck it will be necessary to withdraw the needle out of the muscle fasciae as it is not possible to deflect it otherwise. The needle is No. 17 gauge with a No. 16 gauge lumen, a shaft 15 cm. long, and a short bevel; it is stainless resilient steel.* For especially heavy patients we use a No. 17 needle with an 18 cm. shaft; this, however, has been necessary in only 3 cases.

Before penetrating the aorta and when the tip of the needle is judged to be roughly 2 to 3 cm. from the vessel, a preliminary roentgenogram (survey film) is taken using the identical physical characteristics (exposure time, tube distance, voltage, amperage) as when taking the aortogram but without injection. This will indicate the optimal exposure and also the position of the needle tip. The aorta should be entered normally at T_{12} where it is free from major branches. If the tip of the needle is at L_1, any one or all of the major branches of the aorta may be injected. While the survey film is being developed, any signs of sensitivity to the neo-iopax or urokon are noted. We have seen practically none; in only 2 cases was there vomiting after the intra-aortic injection and these 2 patients had eaten two hours before. The preliminary roentgenogram is inspected and details about the needle point especially noted. The patient has been informed that the delay is to note the position of the needle.

Unless one contacts periosteum with the needle, more procaine is usually unnecessary. The pulsations of the aorta can usually be felt at the finger-tips delicately applied to the butt of the needle. Penetration into the aorta should be done with care as the needle may go right through the vessel. No patient has given evidence of sensation upon puncture of the aorta even without any procaine in the vicinity. Bright red blood issues in spurts, usually for only a short distance because the length and narrow bore of the needle greatly reduce the blood pressure at its external orifice (Poiseuille's law). Two cubic centimeters of the 75 per cent neo-iopax or 70 per cent urokon are injected and the patient is asked whether he feels anything. If extravasation has occurred he will feel pain localized in the back toward the left; this sign is an advantage of local anesthesia. Before injecting the 20 to 40 cc. of iodide as fast as the plunger will go, *i.e.*, in three to five seconds, the patient is warned that he will feel a fleeting warmth in his abdomen, but that he is not to move, and emphasis is put on the "fleeting." We have not seen a patient move under such circumstances. The aortogram is taken while the last 5 cc. are being rapidly injected at which time the roentgenographer holds the patient's nose to stop breathing after a forewarning.

The needle is immediately withdrawn from the aorta but left deeply in the body wall if a second aortogram is desired for a stereoroentgenogram (see below).

A further presumed advantage of translumbar aortography under local anesthesia is that it permits injection during a period of voluntarily forced expiratory effort against a closed glottis, *i.e.*, during the Valsalva maneuver (*cf.* Freeman *et al.*, 1949), thus allowing injection of iodide into an aorta containing relatively stagnant blood. Freeman *et al.* have discussed the dangers of this maneuver in arteriosclerotic patients especially. Antoni and Lindgren

* T462LNR, 17 ga., 6", made to our specification by Becton, Dickinson & Co., Rutherford, N. J.

(1949) have tried aortic compression, *i.e.*, Steno's experiment, by a pillow in 25 cases, with a resultant paraplegia and death in an elderly man due to too long compression.

3. *Roentgenography.* We have used a rotating anode tube at a constant target-to-film distance of 32 inches, a constant current of 300 milliamperes, and a constant exposure time of 1/8 second. The voltage varied from 79 kilovolts for very thin adults to 92 kv. for very obese patients; 82 to 86 kv. has been the rule for a medium adult. For the ten year old child 75 kv. was used. A Potter-Bucky diaphragm is used and a cassette which has two high power Patterson intensifying screens between which the film is fitted. The film is DuPont slow emulsion No. 502, 14 by 17 inches. The technician stands at the roentgenographic table by the patient's head and actuates the exposure by means of a foot-switch. A special circuit is introduced which eliminates the considerable delay between the onset of rotation of the anode tube, set into action by the foot-switch, and the actual exposure.

4. *Stereoroentgenograms.* We have found these useful in indicating whether an artery is retroperitoneal or projects into the peritoneal cavity and thus, for example, have been able to distinguish between branches of the superior mesenteric and renal arteries. Stereoroentgenograms have also helped in ascertaining relationships. In taking the stereoroentgenograms, the target-to-film distance is 32 inches; the second exposure is taken after moving the target off center horizontally for 1 inch and tilting it at 5°.

For a stereoroentgenogram we do not keep the needle in the aorta between injections but draw it out of the aorta for a short distance. Thus, possible tears in the aorta, caused by inadvertent movements of the patient, are avoided. We consider it much safer to puncture the aorta twice than to risk a tear. We wait about ten minutes before taking the second aortogram of the stereoroentgenogram; this allows enough time for the arterial vasoconstriction, which occurs after the injection of neo-iopax (but only very slightly after the injection of urokon), to disappear. This vasoconstriction follows the fleeting vasodilatation caused by neo-iopax (see below on the vascular effects of these iodides).

5. *Post-aortography Treatment.* The patient is returned to the ward on the litter and his blood pressure and pulse are taken every half hour for the first five hours after which he is allowed up if his blood pressure and pulse have been normal. He is allowed water and food freely. We have not noted a significant change in these vital signs other than that produced by the pre-medication prior to aortography.

6. *Tourniquets.* In some cases the effect of completely occluding the blood flow to all four limbs was tried by applying Esmarch tourniquets to all limbs while awaiting development of the survey film. These tourniquets were applied either before a second intra-aortic injection or before the first injection and then released before the second injection. The injections were done at the same speed. No striking improvement was obtained by the tourniquets* except that the internal iliac arteries tended to be more conspicuous with leg tourniquets. An indwelling catheter in the iliac artery showed no change in the mean arterial pressure† upon applying the four tourniquets and practically none upon their removal six minutes later (Case PH 987816). The tourniquets did not prevent the fleeting fall in arterial pressure which occurs immediately after the injection. Complete obstruction of the femoral arteries by tourniquets did not prevent full injection of the external and internal iliac arteries.

7. *Head-Down Position and Aortography Combined with Pneumoretroperitoneography.* In an effort to delineate the vascular supply to the adrenal glands we have performed aortograms up to twenty-four hours after pneumograms (*e.g.*, Fig. 46) and have put the patient in the 20° head-down position

* Confirmed by Larsson and Palmlöv (1952).

† Performed through the courtesy of Dr. Ralph A. Deterling, Jr., of the Department of Surgery.

(*e.g.*, Fig. 47) during the injection in an attempt to separate structures. Both methods are still exploratory and, at present, we think it preferable to perform an aortogram immediately after a good pneumoretroperitoneogram or "pneumogram." The left suprarenal area, at least, appears to be exposed to advantage by the head-down position but the right suprarenal area has been made even more confusing by this position because of overlapping of renal arteries with branches of the hepatic artery.

8. *Contrast Media.* Among the radiopaque media we have used, 80 per cent sodium iodide offers greatest radiopacity and is of relatively low viscosity. We, however, have ceased to use this dangerous solution after our first 2 cases (under pentothal) because we feel safer and obtain satisfactory results with the water-soluble organic iodides, 75 per cent "neo-iopax" (Schering) and 70 per cent "urokon" (Mallinckrodt). While "thorotrast" (Heyden Chemical Corporation), or 25 per cent thorium dioxide, is next after sodium iodide for in vitro radiopacity and low viscosity, it is toxic because of its radioactivity. We have tried it in 2 patients with advanced carcinoma of the bladder with disappointing results. Although in 1 case 45 cc. was injected rapidly (in 5 seconds) through a No. 17 needle the aortogram was relatively faint.* We attribute this to the practical equality in the density and viscosity of blood and "thorotrast" such that the material rides away rapidly with the blood current. Probably for the same reason, reducing the viscosity of 75 per cent neo-iopax, by heating to body temperature, has produced weaker aortograms than the neo-iopax at room temperature, although the former could be injected more rapidly. Incidentally, injection of "thorotrast" causes practically no sensation in patients in whom the aorta was entered under exclusively local procaine.

Seventy per cent "urokon" is the most radiopaque of the extant water-soluble organic iodides which may be used intravascularly; this is due to the three iodine atoms in its molecule compared with two iodine atoms in "neo-iopax."

Seventy per cent "diodrast" (Winthrop) is definitely less radiopaque than 75 per cent "neo-iopax." Aortograms with 70 per cent "urokon" have generally appeared more striking than those with 75 per cent neo-iopax. This was indicated by aortograms performed with these two agents in the same patient through the same needle and site of aortic puncture and with identical speed of injection. "Urokon" was used first in some cases and "neo-iopax" first in others. Most of the aortograms in this paper were performed with 75 per cent "neo-iopax" but the last several with 70 per cent "urokon."†

9. *Age.* Our patients have varied in age from ten (PH 961761) to seventy-three (PH 100325). Advanced age, as such, is not a contraindication. Smith *et al.*[78] (1951) mention 14 moribund patients injected before death to note the effects of the injection on the aortic wall; in 2 of these the aortic puncture was through an atheromatous plaque; yet there was no evidence of hemorrhage and the plaque was not dislodged.

We do not like to inject children below the age of ten because their aorta is quite narrow and tends to have its central axis more toward the midline. This implies more lateral penetration through the body wall with the likelihood of entering stomach and/or pleura. Furthermore, a more lateral approach may injure the thoracic lymphatic duct (see under *Complications* below). The caliber of the normal ascending aorta increases most rapidly up to about the age of twenty and then at a slower steady rate with age (Dotter and Steinberg, 1949). Goodwin *et al.* (1950) tried translumbar aortography in 5 children using a No. 19 or 20 needle and 5 to 10 cc. of contrast

* This has been true also in our recent experiments with canine aortography.

† At the Veterans' Administration Hospital we have performed over 100 successive aortograms with local 0.5 per cent procaine anesthesia and 70 per cent urokon. There have been no complications.

medium. There were 2 failures and 2 with extravasation, 1 of whom was an eighteen month old infant. The youngest patient successfully injected in the extensive series with 800 aortograms by Parke G. Smith *et al.*[80] (1952) was eleven years old.

10. *Caval Phlebography.* We have used this procedure to note obstruction of the inferior vena cava, which would be betrayed by extensive development of collateral venous channels and blockage of the vena cava at or caudal to the renal veins. The sedated patient is given an intravenous test dose of neo-iopax or urokon, as for aortography. He is centered on the roentgenographic table in the horizontal supine position. Esmarch tourniquets are applied to each leg close to the groin to occlude most of the venous return from the legs. The skin over the femoral triangle is sterilized and the femoral vein entered proximal to the tourniquet by means of a No. 18 3 inch needle with a short bevel. Thirty-five to 40 cc. of 75 per cent neo-iopax are injected into the femoral vein rapidly from a 50 cc. syringe connected, by Luer-Lok and a plastic tube, to the needle in the vein. The injection and exposure are performed as for aortography. Care should be taken that the tip of the needle is in the lumen of the vein by injecting a small amount of the "urokon" and aspirating back. We have used both femoral veins satisfactorily, although we prefer the right.* The patient experiences a slight warmth in the abdomen about which he should be forewarned. This method has been used by Fariñas (1947) to demonstrate patency of portacaval anastomosis and by Duff and Granger (1951) and O'Loughlin (1947) for study of inferior vena caval invasion by renal neoplasm. We can add invasion by adrenal neoplasm (see below).

11. *Complications.* Apart from one case to be mentioned below, the most serious complication encountered was laryngeal spasm. This occurred in only a few of our earlier cases, when pentothal anesthesia was used and the anesthetists were inexperienced.

We have had extravasation of neo-iopax with severe temporary pain, localized at the site of injection, in a few cases. In all these, as indicated by roentgenography, the neo-iopax was absorbed within twenty minutes and the pain disappeared before, leaving no after-effect. The initial injection of only 2 cc. to find if pain occurs before proceeding with the full rapid injection is a worthwhile precaution. If arterial spurting is obtained only upon withdrawing the needle it probably means that the aorta has been punctured at an entry and exit. Injection then is likely to produce extravasation. The needle should be withdrawn through the fasciae of the body wall and re-introduced into the aorta at another level.

In one case with only eleven ribs bilaterally and not even a rudimentary twelfth rib the needle entered the aorta at T_{12}, well within the costovertebral pleural reflection (Fig. 21 and 24). The result was localized pleuritis, detectable by roentgenography, lasting a few weeks but which fully cleared. It should be emphasized that the vertebral reflection of the parietal pleura always extends to the twelfth thoracic vertebra regardless of whether a twelfth rib is present. In doubtful cases a roentgenogram of the whole chest should be taken to note whether the most caudal rib is the eleventh or twelfth.

The pleural reflection should always be noted in the survey roentgenogram. We have not seen any significant hemorrhage. Many cases were operated on shortly after aortography and a bare maximal 25 cc. of blood could have extravasated. This was nearly invariably in the psoas and quadratus and outside of the perirenal fascia. In one case a beginning assistant resident inadvertently entered the kidney causing a slight amount of intrarenal bleeding.

In our early trials with aortography under pentothal, Esmarch bandages were used on the legs to occlude the femoral circulation. In one case the Esmarch bandages

* Caval phlebography should be done through the right femoral vein when feasible because of the possibility of partial obstruction of the left common iliac vein by the right common iliac artery.

were left on for one hour. This resulted in paresthesias and weakness of one leg, which symptoms, however, completely disappeared after several weeks.

Our most serious mishap in aortography was a complete severance of the thoracic lymph duct at the level of T_{10}–T_{11}. This patient (PH 079839), as a result, developed massive unilateral chylothorax. Fifteen hundred cubic centimeters of lymph could be aspirated from the chest twenty-four hours after the aortogram, which is within the range of lymph output from the duct noted by others (*cf.* Crandall *et al.*, 1943; Baldridge and Lewis, 1948). The duct, severed at T_{10}–T_{11}, was ligated at both ends within forty-eight hours by Dr. Ray Bhonslay of the Department of Surgery. Upon entering the chest after resecting the ninth rib, Dr. Bhonslay found no blood in the chest cavity. The aortogram was performed by a beginning assistant resident who, having encountered initial difficulty in entering the aorta, used the 18 cm. aortographic needle and entered the body wall far too laterally, thus passing between the aorta and the vertebra and severing the thoracic duct without perforating the aorta. Postoperatively the patient did well and recovered completely.

With adequate precaution and knowledge, most of these complications can be avoided. Aortography, properly done under local procaine and with appropriate water-soluble organic iodide (we now prefer 70 per cent urokon routinely), is harmless and essentially painless.

RESULTS

I. *Effects of Aortography*

1. *Effects on Renal Function.* As indices of renal function we have used several variables: concentration of creatinine and urea in the blood, phenolsulfonphthalein excretion, and twenty-four hour endogenous creatinine and urea clearances. We have also used the intravenous urogram. Table 1 shows no deterioration in renal function in the 2 patients, nonuremic, who received the 17 cc. 80 per cent sodium iodide into their aorta (Cases PH 013280 and 944486). Both patients received 1,000 cc. of isotonic sodium chloride intravenously immediately after the procedure. In the second of these 2 cases (PH 944486) practically all the sodium iodide was injected inadvertently into the right renal artery (Fig. 6). The intravenous urogram taken only two days after the arteriogram nevertheless showed the same ten minute concentration of diodrast by the right kidney as before the arteriogram (Fig. 5 and 7).*

We have found no nephrotoxic effect from 22 to 44 cc. of 75 per cent neo-ipoax injected intra-aortically in 3 uremic patients (Table 1, PH 044719, 036345, 044593).

2. *Effects on the Cardiovascular System.* The changes in systolic and diastolic pressure recorded by the anesthesiologist during our early cases with the intra-aortic injection of neo-iopax under pentothal anesthesia are reported in Table II. The fleeting fall in both diastolic and systolic pressures immediately after the injection is striking and consistent. By measurement of the brachial arterial pressure with the ordinary sphygmomanometer in the patients who underwent aortography under pentothal, it was found that, immediately after the injection, the arterial pressure falls precipitously for several seconds and that this fall may be followed by a mild hypertension lasting several minutes. Furthermore, it was repeatedly noted that, when the second aortogram was performed within a few minutes after the first, the second aortogram would show strikingly fewer of the finer arteries (compare Fig. 3 and 4).

Intrabrachial and intrafemoral arterial pressures were measured, in some of our patients undergoing aortography under local procaine, by Dr. Ralph A. Deterling, Jr. and his co-workers, through fine intra-arterial vinyl catheters connected to Lilly capacitance manometers (see also Deter-

* Miller *et al.* (*Surgery*, 1954, *35*, 885–896) report renal damage from inadvertent direct injections into the right renal artery of 50 to 100 cc. 70 per cent diodrast in patients with advanced aortic sclerosis.

Table I

RENAL FUNCTION BEFORE AND AFTER AORTOGRAPHY

	PH 013280		17 cc. 80% NaI		
	mg. % in serum		PSP % excreted in 2 hr.	Albuminuria	
	Creatinine	Urea-N			
Day before	1.7	11.0	45	1+	
Day after	2.3	12.0	45	1+	
	PH 944486				
Day before	2.1	15.0	35	0	
Day after	6.6	10.0	40	0	
	PH 044719		22 cc. 75% Neo-iopax		
	mg. % in serum		Vol. of urine in 24 hr.	Creatinine clearance	Urea clearance
	Creatinine	Urea-N			
Day before	25.6	115	700	1.5	2.8
Day after	19.8	106	750	2.1	6.9
	PH 036345		22 cc. 75% Neo-iopax		
	mg. % in serum				
	Creatinine	Urea-N			
4 days before	Not taken	46			
1 day before	5.8	Not taken			
1 day after	Not taken	34			
4 days after	6.1	36			

ling, 1952). Coincident with the rapid injection there is a slight elevation of systolic and diastolic pressure lasting only a few pulse waves. In one of our young female patients (PH 044927) with a relatively narrow aorta, Deterling (1952) found a brachial hypertension but a complete dampening of the femoral pressure during the injection. This initial effect is doubtless due to the mechanical impact of the injection because Deterling has produced it in dogs even when merely isotonic sodium chloride was injected rapidly. For the first minute or so following the initial mechanical effect there is a fleeting fall in arterial pressure, sometimes quite pronounced, and then a rapid rise to normal and gradually hypertensive levels. After ten minutes the patient's initial arterial pressure is regained. These fluctuations are most marked with 75 per cent neo-iopax, less so with 70 per cent diodrast, and barely appreciable with 70 per cent urokon. This is another advantage of urokon. Dr. Deterling will report on these trials with urokon in detail. In the unanesthetized patient (PH 032145), at least 47 cc. of thorotrast had no appreciable vasomotor action but the disadvantages of thorotrast have been mentioned above. No perceptible changes were obtained in intra-arterial pressure when 70 per cent urokon was used for caval phlebography (PH 090130).

In 4 cases the superior mesenteric artery alone was inadvertently injected with 75 per cent neo-iopax without untoward re-

TABLE II

BRACHIAL ARTERIAL PRESSURES, AS MEASURED WITH AN ORDINARY SPHYGMOMANOMETER, IN PATIENTS WHO UNDERWENT AORTOGRAPHY UNDER PENTOTHAL

Unit No.	030337		025352	001292	019699	569489
Remarks	Blood pressure	Pulse	Blood pressure	Blood pressure	Blood pressure	Blood pressure
Before pentothal	160/70	108	180/90	170/120	100/60	—
With pentothal	160/70 140/70	100 100	140/90	160/110	100/70	110/70
Immediately after puncturing aorta	—	—	—	—	90/60	—
Immediately after injection	100/60	110	100/50	140/105	80/60	90/50
15 sec. later	—	—	120/80	—	—	—
30 sec. later	—	—	140/100	—	—	—
45 sec. later	—	—	150/100	—	—	—
2 min. later	150/90	108	—	160/110	—	—
3 min. later	—	—	—	—	—	105/70
5 min. later	—	—	—	155/110	—	—

sults (Fig. 1 and 2). PH 852152 received two 35 cc. injections of 75 per cent neo-iopax and felt only "a pleasant, not unwelcome warmth." Another case, PH 079700, remarked about "a very uncomfortable sensation" in the belly lasting one to two minutes; his superior mesenteric artery had received 35 cc. 75 per cent neo-iopax. A large male patient received 22 cc. 75 per cent neo-iopax chiefly into the middle colic branch of the superior mesenteric artery (Fig. 1). All 4 patients who received the injection into the superior mesenteric artery felt well after and ate supper that day. We are thus able to confirm Parke G. Smith *et al.* (1951) on the relative harmlessness of 75 per cent neo-iopax to arteries. These inadvertent injections were done early in the series and now we avoid them by always entering the aorta well up at T_{12} where it is free from major branches. This position is attained not only by practice in inserting the needle but also by the preliminary survey roentgenogram with the needle in place close to but not in the aorta.

In one case (PH 076984) the needle slipped out of the lumen of the aorta during the beginning of the injection and the entire injection of 35 cc. of 75 per cent neo-iopax occurred in the wall of the aorta which was markedly calcified. Nevertheless, the patient continued to have full pedal arterial pulses and underwent nephrectomy for renal adenocarcinoma. A similar instance has been reported by Parke G. Smith *et al.* (1951).

We have performed aortograms under local anesthesia on several patients with electrocardiographic evidence of coronary sclerosis without mishap. Thus, PH 907466 had a moderately severe myocardial infarct in 1948 and had a "healed anteroseptal myocardial infarction with extension"; he was on digitoxin for right-sided failure and on a low NaCl diet; he experienced merely a pleasant warmth during the injection and no harmful sequelae. PH 997356 had coronary sclerosis by electrocardiogram but no recent infarct; his blood pressure was 220/110. He showed no injury after aortography; this being confirmed by electrocardiogram. Intra-arterial pressure recordings by Dr. R. A. Deterling, Jr., showed the usual immediate fall in arterial pressure lasting several seconds after intra-aortic injection of the neo-iopax. PH 927274 was similar; a solitary cyst was later excised from the superior pole of his right

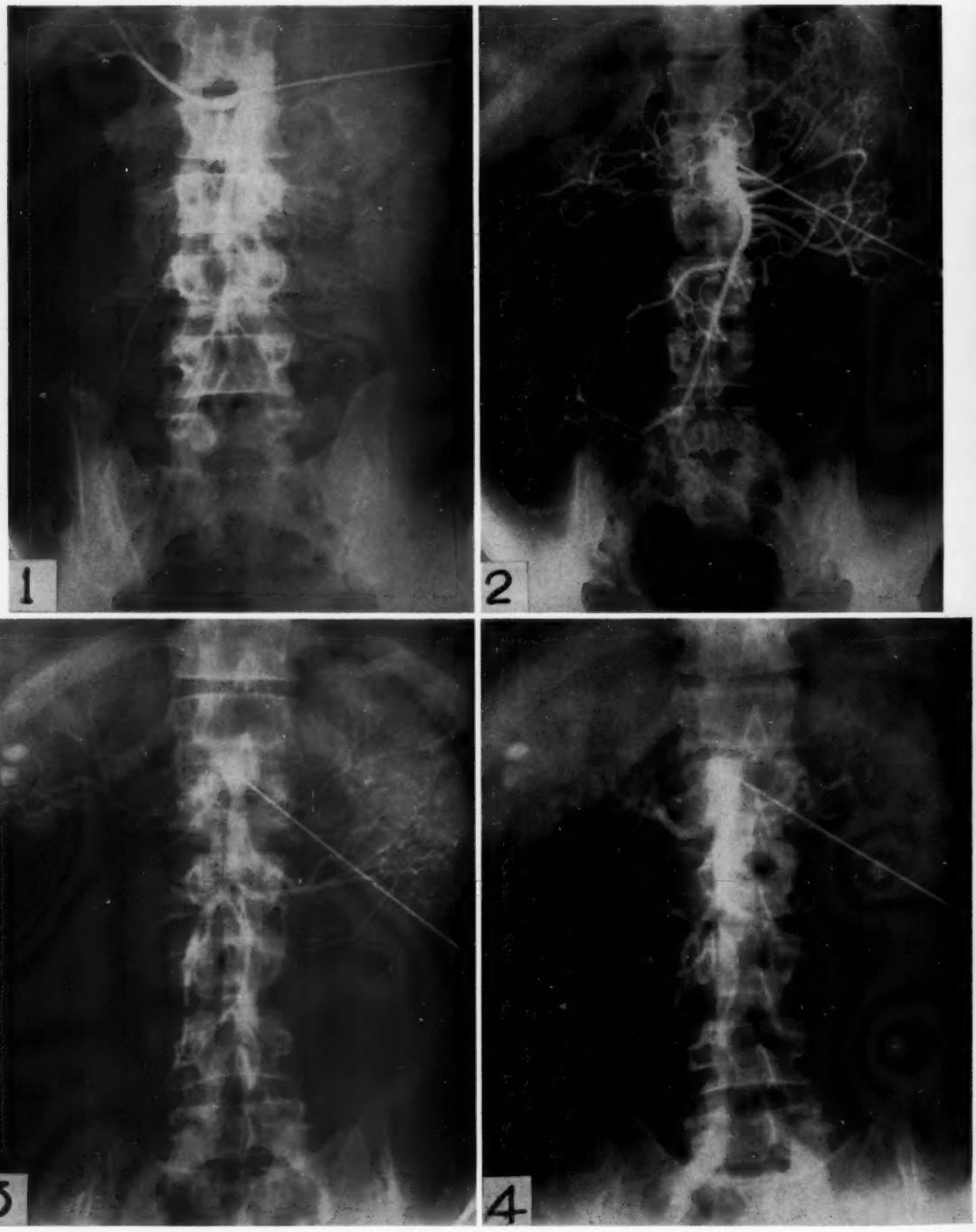
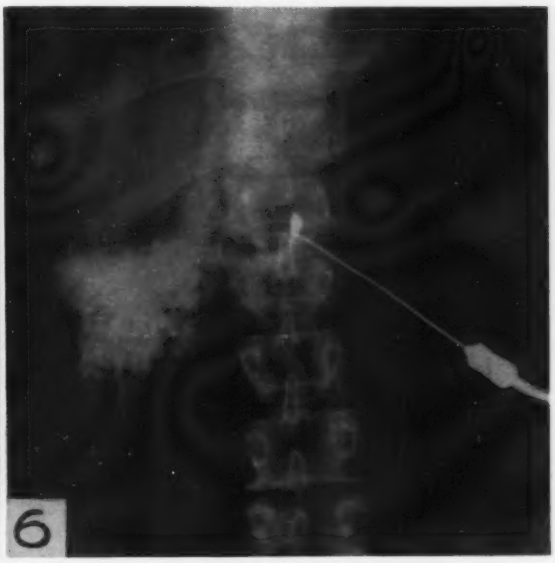


Fig. 1. PH 951235. Injection of 22 cc. 75 per cent neo-iopax with needle tip inadvertently in the middle colic branch of the superior mesenteric artery. A subsequent aortogram demonstrated this branch to be the middle colic and not the hepatic branch of the celiac artery. There were no ill after-effects. Pentothal anesthesia.

Fig. 2. PH 045080. Injection of 22 cc. 75 per cent neo-iopax inadvertently practically exclusively into the superior mesenteric artery. No. 17 needle. Local procaine. No ill after-effects.

Fig. 3. PH 033066. Injection of 20 cc. 75 per cent neo-iopax. No. 17 needle. Local procaine. Aortogram performed because of question of deformity of right renal pelvis in the retrograde pyelogram.

Fig. 4. PH 033066. Injection of 20 cc. 75 per cent neo-iopax three minutes after the injection in Figure 3. into the same patient with the same speed of injection. Note markedly diminished visualization of the mesenteric arteries.



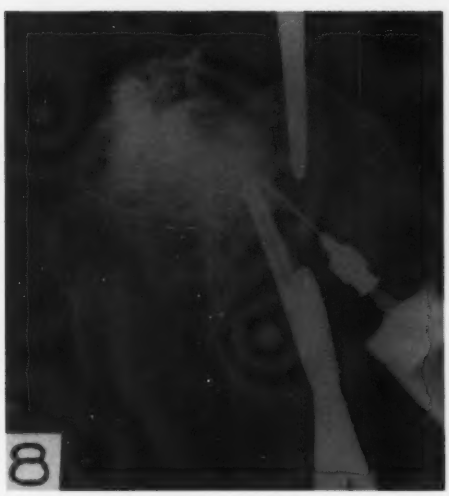


Fig. 5. PH 944486. Excretory pyelogram at ten minutes after injection of 20 cc. 35 per cent diodrast intravenously. This was done several days before the aortogram.

Fig. 6. PH 944486. Aortogram with 17 cc. 80 per cent sodium iodide. No. 18 needle. Note extensive puddling of iodide in the carcinomatous right kidney. Same patient as Figure 5.

Fig. 7. PH 944486. Excretory pyelogram at ten minutes after injection of 20 cc. 35 per cent diodrast intravenously. This was done two days after the aortogram.

Fig. 8. PH 944486. Injection of iodide into the renal artery after nephrectomy; note the pooling.

kidney. PH 954291, a diabetic patient with a large renal abscess, had coronary sclerosis and was on digitoxin. We would not attempt aortography in a patient with an unhealed myocardial infarct. We would now use 70 per cent urokon rather than 75 per cent neo-iopax, especially in patients with coronary sclerosis, because urokon evokes only slight, if any, fluctuations in arterial pressure.

3. *Effect of Stimulation of a Main Branch of the Sciatic Nerve on the Caliber of the Renal Arteries.* Trueta *et al.* (1946,1947) found, in a certain percentage of rabbits, that

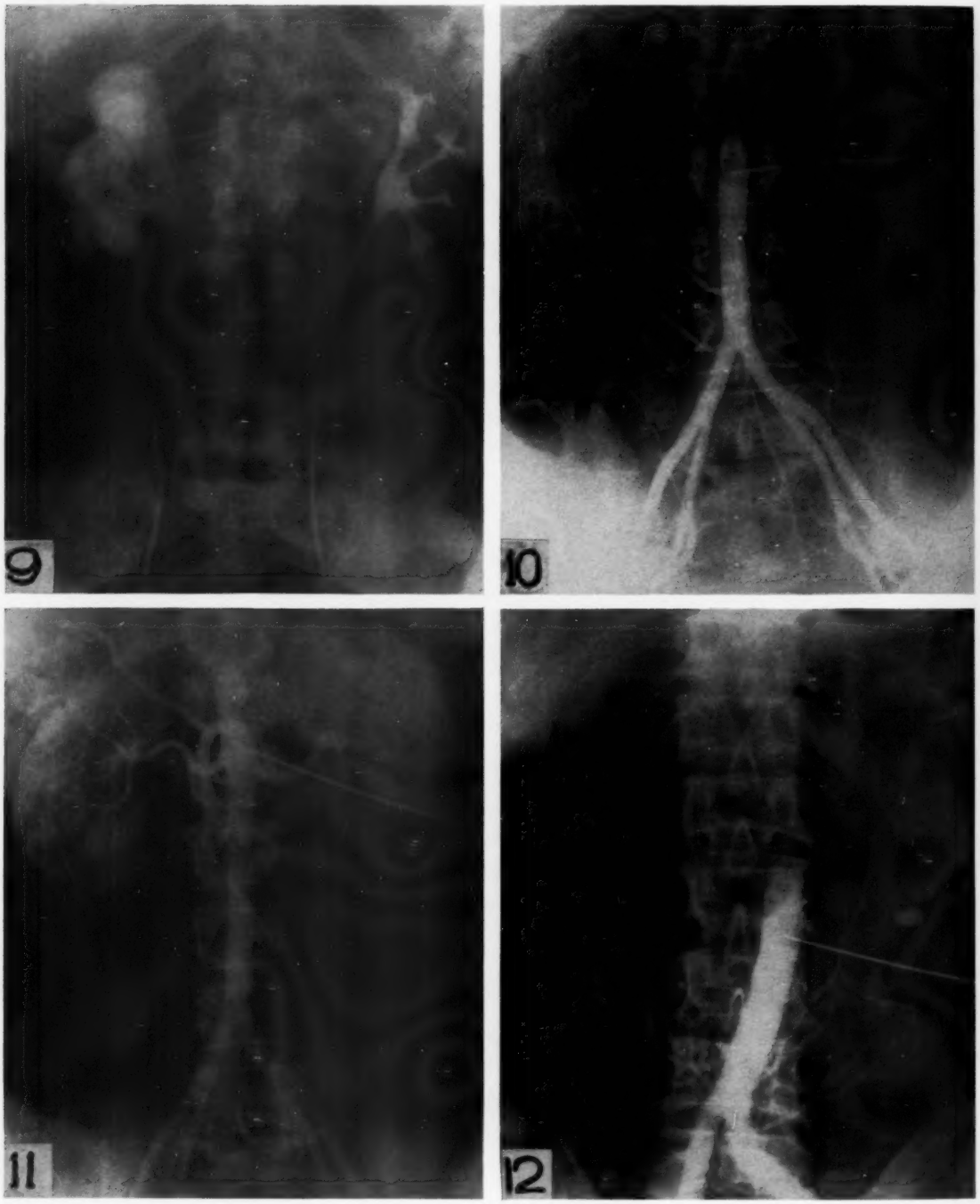


Fig. 9. PH 974463. Retrograde pyelogram showing a congenital hydronephrosis of the right kidney.

Fig. 10. PH 974463. Aortogram by injection of 35 cc. 75 per cent neo-iopax into the aorta at L_3. No. 17 needle; pentothal. The left renal artery and the upper right renal artery are not injected. The polar or aberrant arteries supplying the lower pole of the right kidney, arising from the lower end of the aorta and from the right common iliac, are injected producing a right heminephrogram. This is a physiological graphic indication that renal arteries are end-arteries.

Fig. 11. PH 974463. Second aortogram, in the same patient as in Figure 10, by injection at L_1–L_2. All the renal arteries are injected. The aberrant arteries cannot be identified with certainty by this aortogram.

Fig. 12. PH 079700. Aortogram by a low injection at L_2–L_3 demonstrating with certainty the lower renal arteries to this horse-shoe kidney by their nephrogram.

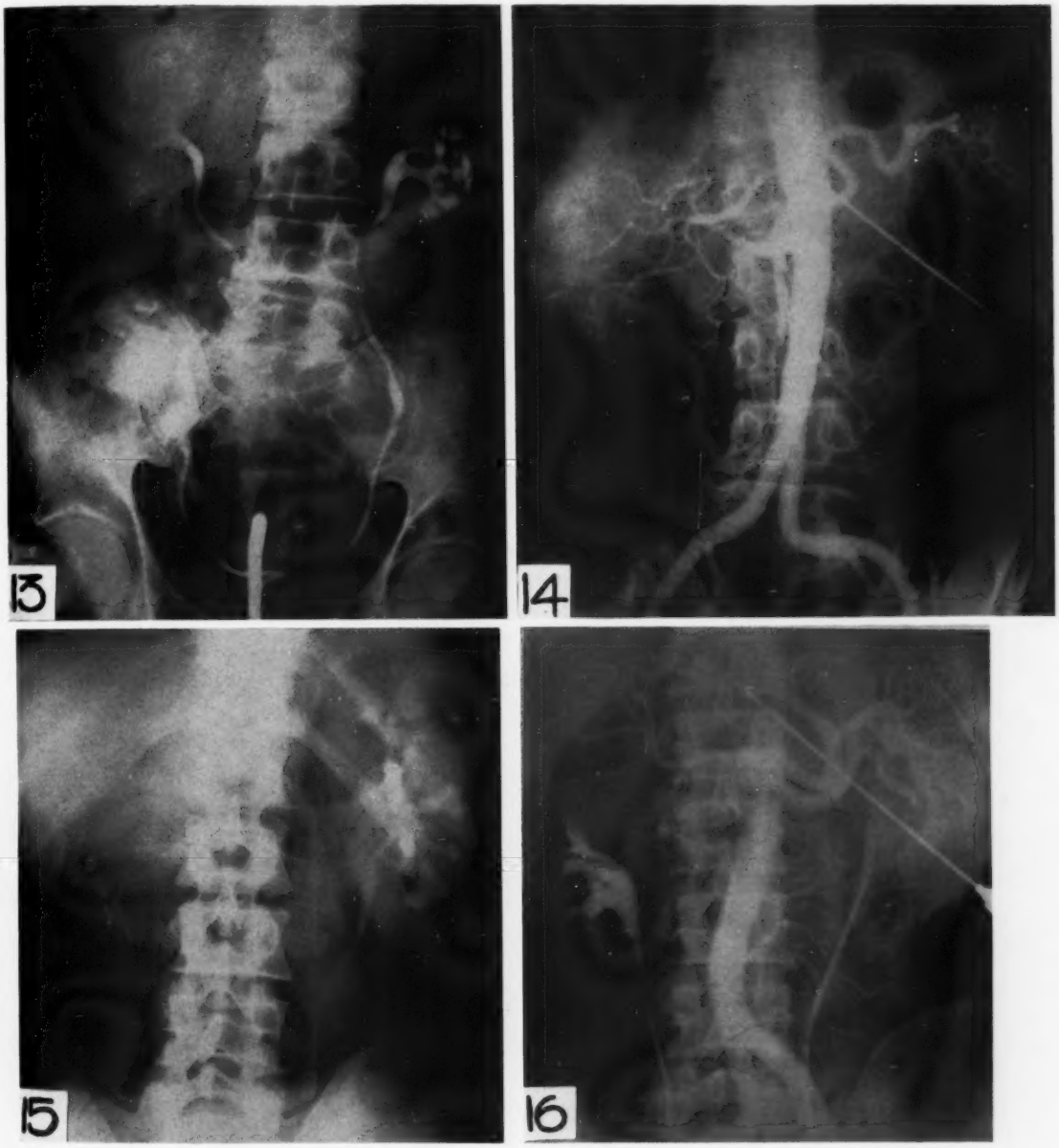


Fig. 13. PH 997356. Retrograde pyelogram in a hypertensive fifty-nine year old male (blood pressure 120/110) with a hypoplastic left kidney; coronary sclerosis.

Fig. 14. PH 997356. Aortogram in the same patient as Figure 13 showing the very small left renal artery corresponding to the hypoplasia of the left kidney. Twenty-two cubic centimeters of 75 per cent neo-iopax, local procaine. The right renal artery is normally developed or somewhat hypertrophied.

Fig. 15. PH 868669. Excretory pyelogram in a forty-two year old male with a hypoplastic right kidney, with pelvic calculi in the right kidney, but without hypertension (blood pressure 110/70).

Fig. 16. PH 868669. Aortogram in the same patient as in Figure 5 showing the hypertrophied left renal artery and the practically absent right renal artery; 22 cc. 75 per cent neo-iopax; local procaine.

stimulation of the central end of a divided sciatic nerve caused two phenomena: (1) diminution in caliber of the renal arteries, and (2) shunting of a large fraction of the renal circulation from the renal cortex to the medulla. In unanesthetized patients

we attempted to simulate his experiments as closely as was feasible.

An aortogram was taken of a given patient in the usual manner under local anesthesia, care being taken in these cases not to infiltrate procaine deeper than the skin and subcutaneous tissue. With experience the aorta can be entered painlessly upon infiltration of only the skin and subcutaneous tissue with procaine. After taking the first aortogram the needle was withdrawn about 3 cm., *i.e.*, so that it was no longer in contact with the aortic wall but was in place so that it could be re-introduced readily at about the same site. The skin over the tibial nerve in the popliteal fossa was infiltrated with procaine and the unexposed tibial nerve stimulated by faradic induction shocks from a neurological inductorium.* The intensity of stimulation was such as to maintain the ankle in plantar extension by forced clonic or tetanic contraction of the calf muscles. This was not intolerably uncomfortable and was continued for thirty minutes. At the end of the period of stimulation, but while it was still proceeding, a second aortogram was taken under identical roentgenographic characteristics as the first aortogram.

There was marked narrowing of the renal arteries upon faradic stimulation of the right tibial nerve in a youngish woman (PH 987816; see Fig. 28 and 29). The result was most striking. Consistent data, subsequently obtained, will be described in detail elsewhere.† There seems, therefore, to be definite evidence that the main renal arteries may constrict from sciatic nerve stimulation. So far as we know this is the first objective indication that this can occur in human beings. We shall thus go along with the *first phenomenon* of Trueta and his colleagues in believing that the main renal arteries may constrict when the sciatic nerve is stimulated. This does not, however, imply shunting of blood from the renal cortex, which may be termed Trueta's *second phenomenon.*

II. *Aortography and Caval Phlebography as Urological Diagnostic Procedures*

1. *Differentiation between Adenocarcinoma and Cyst.* The cysts appear as relatively blank areas, with deficient or absent arterial supply, and are circumscribed by intrarenal arteries (Fig. 50 to 69). Renal adenocarcinoma typically shows extensive pooling of the iodide owing to necrotic regions with relatively dilated blood channels (Fig. 32, 33, 36, 37, 38, 40, 41 and 42). In the differentiation between neoplasm and cyst we were correct in 46 cases out of 49 (Table III).‡ Most of these cases came to surgery§ or necropsy. A few had sufficiently long follow-up to exclude neoplasm. In some cases the retrograde pyelograms were indicative of tumor and so was the appearance at surgery, such as dilated perirenal veins and relative immobility of the kidney, only to have the aortographic diagnosis of multilocular cyst confirmed by gross and microscopic study (PH 029974 and 036963; Fig. 52 and 53). In one case (PH 016198) the mass occupied the center of the kidney by pyelography and an anterior transperitoneal approach was scheduled because neoplasm was thought to be the most likely lesion. An aortogram disclosed cyst and the operation was changed to the simple flank approach; cyst was confirmed. On the other hand, in an early case (PH 852152) when the validity of aortography in diagnosis was held yet skeptically, pooling of iodide was reported by aortography. At surgery only a cyst wall was excised; there were several multiloculated cysts in the mid-portion of the renal parenchyma; the largest was the size of a small lemon. Eleven months later the patient was readmitted with inoperable adenocarcinoma of that kidney; aortography now showed pooling of iodide not only throughout the

* Kindly supplied by Dr. Joseph Moldaver of the Neurological Institute at Columbia University.

† Maluf, N. S. R. Effect of electrical stimulation of medial popliteal nerve on caliber of renal arteries in unanesthetized man. *Angiology*, 1954, *5*, 537–553.

‡ In the Veterans Administration Hospital, Houston, aortography led to correct diagnosis in 8 out of 8, all of which were confirmed by surgical specimen (Reg. No. 27993, 44868, 45848, 47043, 32578, 47619, 29092, 28644).

§ Operations performed by members of the Attending and Resident Staff.

Fig. 17. PH 040486. Left retrograde pyelogram showing the left pelvic kidney.

Fig. 18. PH 04086. Aortogram of same patient as in Figure 17 showing the hypertrophied right renal artery and the small left renal artery running caudad from the bifurcation of the aorta.

Fig. 19. PH 044593. Aortogram in a forty-nine year old female with rheumatic heart disease, auricular fibrillation, sudden pain in left renal region with gross hematuria, pain in the legs. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. The left renal artery and right common iliac artery are occluded presumably by mural thrombotic emboli.

Fig. 20. PH 015664. Aortogram showing a hypertrophied right renal artery and apparently a stump of a small left renal artery; marked hypoplastic left kidney. No. 17 needle; 22 cc. 75 per cent neo-iopax, local procaine.

TABLE III

DIFFERENTIAL DIAGNOSIS OF RENAL ADENOCARCINOMA AND CYST

Unit No.	Impression from all Nonaortographic Procedures	Impression from Aortography	Pathological Diagnosis
013280	Indefinite	Cysts or abscesses	Abscesses
944486	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
019699	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
001292	Cyst	Cyst	Follow-up cyst
025352	Cysts, multiple	Cysts, multiple	Cysts, multiple
569489	Cyst	Cyst	Follow-up cyst
030337	Adenocarcinoma	Multiple cysts	Multiple cysts
852152	Cyst	Adenocarcinoma (later carcinoma with extension)	Adenocarcinoma with extension
029975	Adenocarcinoma with extension	Cysts	Cysts and perirenal fibrous adhesions
036963	Adenocarcinoma most positively	Cysts	Cysts
030563	Cyst	Cyst	Cyst
042736	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
032145	Pyonephrosis and perinephritis	No carcinoma	Pyonephrosis and perirenal abscess
035256	Cyst	Cyst	Cystadenoma or cystadenocarcinoma
951901	Cyst	Cyst	Cyst
865441	Cyst	Cyst	Follow-up cyst
053794	Cyst	Cyst	Cyst
995806	Cyst	Cyst	Cyst
064596	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
066374	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
927274	Adenocarcinoma	Cyst	Cyst
068931	Sarcoma or adenocarcinoma	Sarcoma	Sarcoma*
016198	Adenocarcinoma	Cyst	Cyst
954291	Abscess, carcinoma or cyst	Abscess or cyst	Abscess
070907	Adenocarcinoma	Adenocarcinoma with extension	Adenocarcinoma with extension
067220	Papillary carcinoma or hemangioma	Papillary carcinoma or hemangioma	Papillary carcinoma
072193	Adenocarcinoma of adrenal	Adenocarcinoma of adrenal	Adenocarcinoma of adrenal
981584	Polycystic; possible carcinoma	Polycystic; no carcinoma	Polycystic; no carcinoma
075254	Cyst	Cyst	Cyst
081714	Indefinite	Cyst	Cyst
081769	Cyst	Adenocarcinoma	Adenocarcinoma
083980	Cyst	Cyst	Tubular cystadenoma
099583	Cyst	Cyst	Cyst
100348	Adenocarcinoma	Adenocarcinoma with extension	Adenocarcinoma with extension*
100807	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
097063	Cyst	Cyst	Cyst
899993	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
094237	Cyst	Cyst	Cyst
102758	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma*

* Diagnosis confirmed after patient had been transferred to the Delafield Hospital, in charge of Dr. Perry B. Hudson.

TABLE III—(*continued*)

Unit No.	Impression from all Nonaortographic Procedures	Impression from Aortography	Pathological Diagnosis
011778	Cyst	Cyst	Cyst
106504	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
110820	Cyst	Adenocarcinoma	Adenocarcinoma
340393	Indefinite	Adenocarcinoma	Hemorrhagic patch; trauma
727154	Hydronephrosis or carcinoma	No carcinoma	Hydronephrosis; no carcinoma
090130	Cyst	Cyst	Follow-up cyst
106731	Cyst	Cyst	Cyst
050863	Adenocarcinoma with extension	Adenocarcinoma with extension	Adenocarcinoma with extension
Total errors (excluding noncommitments)	8	3	
Per cent of error	17.0	6.4	
No. of noncommitments	5	1	
Per cent noncommitment	10.3	2.1	

kidney but beyond its confines medially and cephalad (Fig. 42).

Adenocarcinoma of the kidney betrays itself by pooling of iodide in this organ. The carcinoma may be confined to a small region of what might appear to be a large solitary cyst by retrograde pyelography but demonstrable as pooling by aortography (Fig. 40 and 41). The pooling is not due to dilated perirenal veins because: (1) it is demonstrable in the isolated injected kidney (Fig. 6 and 8), and (2) it may not occur even when the perirenal veins are prominently dilated about a multicystic kidney (PH 029974 and 036963).

We have made the diagnosis of rapidly growing sarcoma of the kidney in a fifteen year old boy with a large mass extending from his right kidney which was invaded directly by the intrarenal arteries which branched profusely without giving the appearance of being deflected. There was no visible pooling of iodide (Fig. 43 and 44). At necropsy a reticulum cell sarcoma was found. The case was inoperable. A myxoblastic sarcoma of the kidney with a similar aortographic picture has been reported by de Moura (1950). Ducuing *et al.* (1949) noted pooling of iodide in a pelvic sarcoma.

We have not been able to differentiate cyst from cystadenoma (PH 035256 and 083980). In the former case (Fig. 57) cyst was diagnosed and its wall was excised; spillage of fluid occurred in the retroperitoneal space. At pathological examination, however, papillary cystadenoma or "cystadenocarcinoma" was found in the wall and a repeat operation had to be performed for a total left nephrectomy. Now, after over two years, the patient remains without signs of metastases. Abscess may be differentiated from simple cyst by considering the history of the case, possible fever, local tenderness, diabetes mellitus, pyuria and other signs (Fig. 61). Wagner (1946) has found pooling of iodide in a kidney with liposarcoma. This is, however, a rare disease and often accompanied by other physical signs so that it need not be confused with adenocarcinoma.

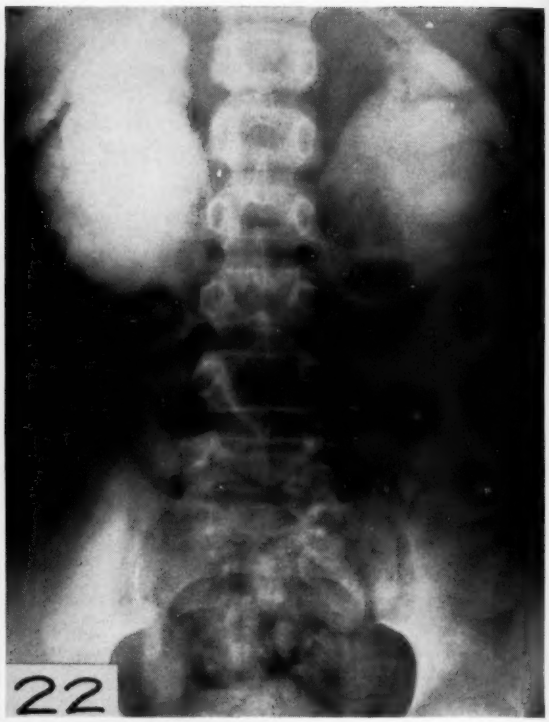


FIG. 21. PH 817923. Aortogram of a twelve and a half year old boy with congenital bilateral hydronephrosis. Both renal arteries are of somewhat subnormal caliber. Note the nephrograms of these lobulated kidneys. No. 17 needle; 30 cc. 75 per cent neo-iopax; pentothal.

FIG. 22. PH 817923. The pyelo-ureterogram taken two hours after the intra-aortic injection of 30 cc. 75 per cent neo-iopax in the same patient as in Figure 21. The renal pelves are here depicted and are obviously mainly extrarenal as they exceed the area of the nephrograms in Figure 21.

FIG. 23. PH 022831. Right renal arteriogram showing the rich vascular supply, tortuous vessels, weak nephrogram in a kidney (right) with perinephritis, pyonephrosis, and calculi. No. 17 needle; 30 cc. 75 per cent neo-iopax; pentothal.

As regards papillary carcinoma of the kidney, we do not think that aortography is of much value; it can merely exclude *adeno*-carcinoma.

In a case with advanced papillary carcinoma of the kidney with hilar and periaortic lymph node involvement no pooling could be seen in a satisfactory aortogram (PH 054519).* In another case with early papillary carcinoma (PH 067220) faint pooling of iodide was noted in the renal parenchyma adjacent to the renal pelvis from which the papillary growth arose.

There has been no difference in the "pooling effect" in the aortogram among neoplasms composed of relatively pure granular cell carcinoma (PH 852152, 081769, 100807), of mixed granular and clear cell carcinoma (PH 019699, 066374, 050863) or of clear cell carcinoma (PH 070907, 944486, 064596, 106504, 110820).

Our three errors of diagnosis consisted of a tubular cystadenoma, a questionable cystadenocarcinoma, and a traumatic bleeding into the kidney caused by the aortographic needle. The last-named error can be avoided, but the first two cannot by our present knowledge of renal arteriography. Unless the patient is a poor risk or refuses surgery, all solitary cysts, even when thus diagnosed by aortography, should be explored in the event that they be adenomas. The prevailing opinion is that papillary cystadenomas, tubular adenomas, alveolar adenomas and the various intergrades are potentially precancerous neoplasms (Carver, 1935; Cabot and Middleton, 1938; Ewing, 1941; Braasch and Hendrick, 1944; Bugbee and McKay, 1944; Buckley, 1944; Cristol *et al.*, 1946; Deming, 1946; Herbut, 1952, and others) and thus warrant consideration of more careful and radical measures than mere partial excision of "cyst wall."

* In another case (V.A. Hosp. 47619) of papillary carcinoma no pooling of iodide was present although the corresponding renal artery was well injected. On the basis of other findings radical nephro-ureterectomy was performed. The specimen showed prongs of tumor cells invading deeply into the renal parenchyma with considerable surrounding fibrosis but *without necrotic vascular spaces.*

We had occasion to obtain an aortogram of a patient (PH 046820) with metastatic carcinoma of unknown origin even though he had a normal pyelogram. No pooling of iodide was noted although his renal arteries were well injected. Adenocarcinoma of the kidney was thus ruled out, we believe. We have also obtained an aortogram in a patient (PH 062221) with a known extrarenal focus of carcinoma with questionable deformity of one renal pelvis.

A fixed enlarged kidney due to pyonephrosis and perinephritis may be differentiated from adenocarcinoma by the absence of pooling of iodide in the aortogram (PH 032145).

Hemorrhage into the kidney from mechanical trauma may show pooling in the aortogram. If this hemorrhage is due to perforation and laceration of the kidney by the aortographic needle, it may lead to an unnecessary nephrectomy. We have one such case (PH 340393) in whom there was a 2 by 2 by 0.5 cm. hemorrhagic patch in the cephalic pole of the left kidney and in the perinephric fat; the aortogram had been done by a beginning assistant resident. It is especially necessary to guard against such an occurrence, which we have seen only this once, because it is technically incorrect to explore a kidney with carcinoma. A resectable cancerous kidney should be mobilized with its perirenal fascia (of Gerota) after division of its pedicle and may not even be actually visible at surgery (see Fig. 70 to 73). It is advantageous to establish the diagnosis of adenocarcinoma of the kidney by aortography and thus plan for adequate surgery for cancer. It would be disconcerting, to say the least, to have to decide whether a tumor were cyst or cancer only after entering the perirenal fascia and then finding cancer. Yet this, we suspect, occurs frequently. An aortogram, by indicating the necessity for wider surgery, may save a patient's life.

A large carcinoma of the *adrenal gland* may betray itself by pooling in the aortogram (Fig. 46) but we have not had the opportunity of performing aortograms on

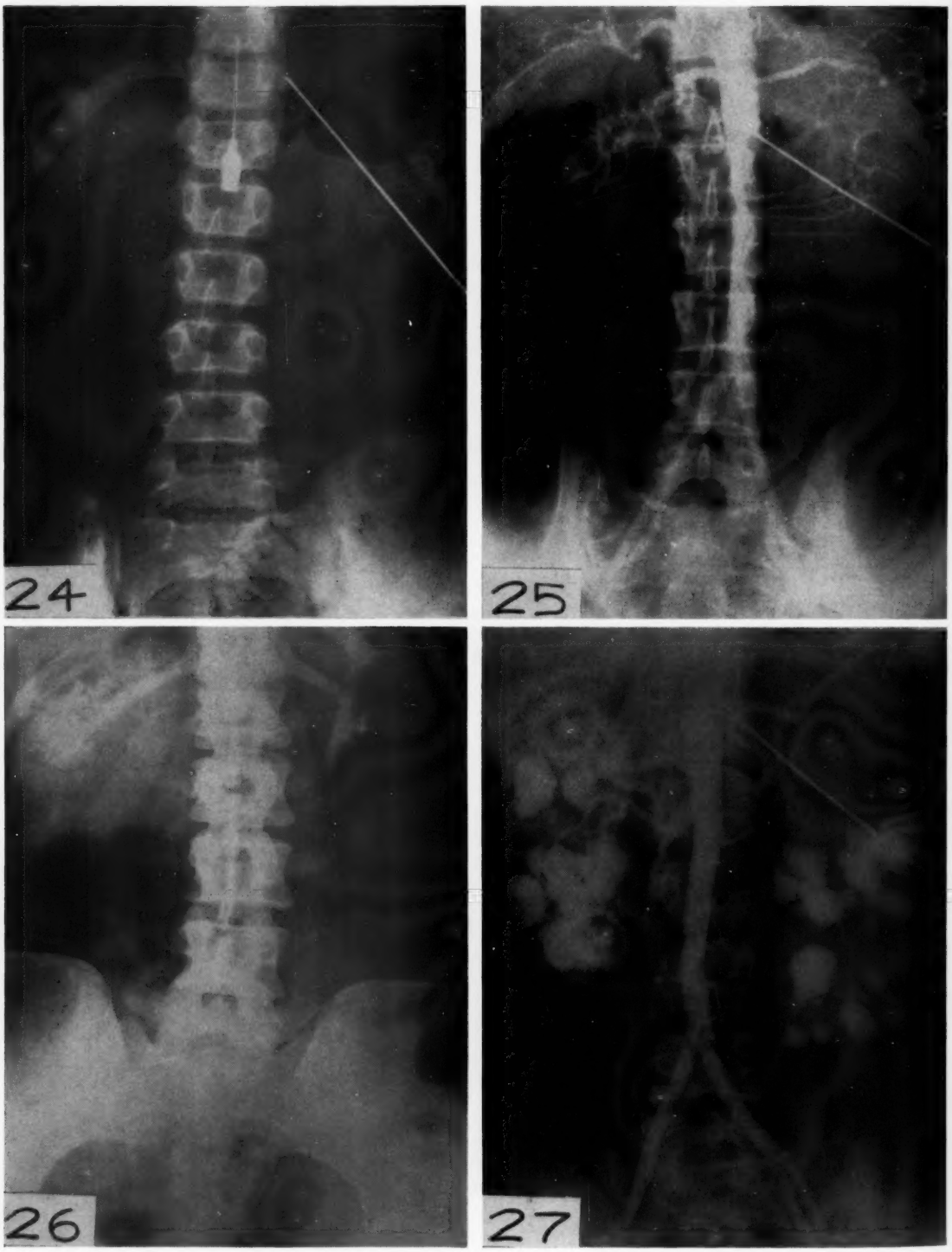


Fig. 24. PH 817923. Plain film with needle almost in aorta in a twelve and a half year old boy with only eleven ribs. Note the pleural reflection extending to the twelfth thoracic vertebra and note that the needle is actually in the pleura. This resulted in a localized pleuritis which lasted several weeks but was largely asymptomatic.

other cases of adrenal carcinoma. We have examined the aortograms of several cases with adrenal hyperplasia but have seen no pooling (*e.g.*, Fig. 47). A benign tumor of the adrenal gland, producing a "pure" Cushing syndrome, also showed no pooling although the branches to the adrenal were well injected (PH 753165). A massive sympathicoblastoma of the adrenal gland did not show any pooling of iodide (Fig. 48) even though it had already invaded the inferior vena cava (Fig. 49, confirmed by necropsy). Milanés *et al.* (1950) have displayed the arterial supply to an adrenal tumor with excellence (see their Fig. 13). Gilbert-Dreyfus *et al.* (1950) attempted to depict an adrenal tumor by aortography and reported merely an elongation and depression of the ipsilateral renal artery.

Credit is due to dos Santos and his coworkers (1929, 1931) in Lisbon, Portugal, not only for introducing translumbar aortography but for making the astute observation that adenocarcinoma of the kidney may be diagnosed by the "bloody lakes" indicated by pooling of radiopaque medium in the lesion. They also noted and recorded graphically similar pooling by aortography in an adenocarcinoma of the sigmoid colon[69] (1931) and in malignant tumor of bone[71] (1947). We have seen pooling by aortography in an extensive metastatic prostatic carcinoma to the ilium and buttock (VA Hosp. No. 26375). Shortly before the work of dos Santos *et al.*, Egas Moniz (1927, 1928), also of Lisbon, had introduced cerebral arteriography as a diagnostic procedure in neurology.

2. *Course of the Renal Artery to a Neoplastic Kidney.* The surgery of cancer sets the ideal of extirpating the neoplasm without cutting through it and without mauling the tumor before its potential channels of dissemination, namely its veins and lymphatics, have been clamped and divided. Neoplasms of the kidney can distort relations so as to make direct approach to the renal pedicle difficult even by the anterior transperitoneal or by the posterior extrapleural transthoracic approach of Nagamatsu. In such cases a thoraco-abdominal approach may be the procedure of choice. The course of the renal artery and its relation to the thoracic cage and to the renal shadow could give a clue as to the readiest way to obtain the pedicle and thus the renal vein(s) without undue manipulation of the kidney. Thus, in PH 106504 the low left renal artery correctly showed that an anterior transabdominal approach could be performed with ease. In PH 081769 the aortogram not only gave the diagnosis but also assisted in a direct approach to the pedicle. The existence of polar arteries above or below the main renal artery was also displayed in some aortograms.

3. *Polar and Aberrant Renal Arteries.* We have obtained aortograms almost routinely from patients with hydronephrosis without hydroureter and without obstructing renal pelvic calculus. This has been done preoperatively to note the possible existence, location, and direction of an obstructing polar or an aberrant artery. For this we have combined a retrograde pyelogram with the aortogram on a single film (Fig. 31). The ureteral catheters are inserted shortly prior to aortography and left indwelling, the patient being instructed not to flex her hips. She is transferred recum-

Fig. 25. PH 892190. Aortogram in a patient with an acute calculus obstruction of the lower right ureter. Note that the right *instantaneous* nephrogram is much less intense than the nephrogram of the left unobstructed kidney. No. 17 needle; 25 cc. 75 per cent neo-iopax; local procaine.

Fig. 26. PH 892190. *Delayed* (40 minute) more intense nephrogram of the obstructed right kidney of same patient as in Figure 25.

Fig. 27. PH 080640. Aortogram of a patient with numerous calculi in both kidneys (has Albright's syndrome of hyperchloremic acidosis), but only the left ureter is blocked by a calculus. The "instantaneous" nephrogram is thus much weaker on the left than on the right. Note also the narrowed left renal artery and poorer visualization of the arterial supply to the left kidney. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine.

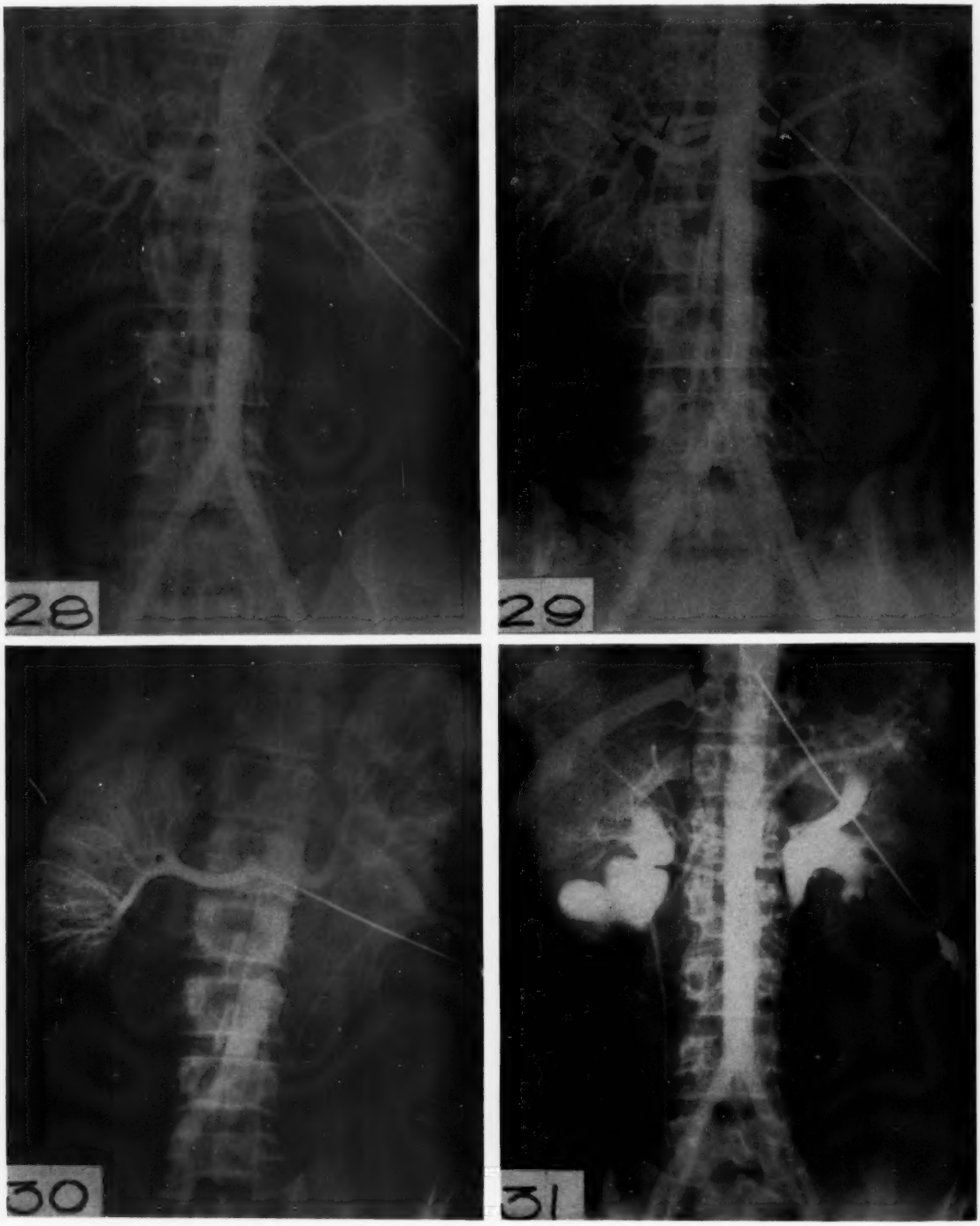


Fig. 28. PH 987816. Aortogram of a twenty-nine year old female with normal arterial supply to both kidneys and normal nephrograms. No. 17 needle; 40 cc. 75 per cent neo-iopax; local procaine.

Fig. 29. PH 987816. Aortogram of the same patient as in Figure 28 taken during stimulation of the middle popliteal nerve by tetanizing faradic induction shocks which had been instituted continuously for fifteen minutes. This aortogram was done through the same needle and after the initial aortogram of Figure 28. Note the marked narrowing of the renal arteries (indicated by arrows).

bent to the roentgenographic table and the organic iodide injected into the ureteral catheters after the aorta has been entered but before it has been injected. We do not advise, otherwise, a combination of retrograde pyelography with aortography because the pyelogram tends to obscure the vascular detail in the kidneys. An alternative technique, which we have used recently, is to superimpose an aortogram on an intravenous urogram.

In the diagnosis of polar artery we have been correct in all of 11 cases as confirmed by surgery. Thus, in 11 cases of hydronephrosis without hydroureter or renal pelvic calculus we found a responsible polar artery in only 2 cases, and in 1 other case (PH 946869) the polar artery had been divided prior to aortography. In 1 case (PH 974463) the existence of aberrant artery to caudal pole of the right kidney directly from the caudal end of the aorta was established by injecting the aorta low at L_3, thus obtaining a heminephrogram and arteriogram (Fig. 10) and bringing out, pictorially, in the living human being the fact that the renal arteries are end-arteries. The second injection was made at L_1–L_2 a few minutes later, injecting all the renal arteries (Fig. 11). Note that no iodide has passed out of the aorta through the initial aortic puncture at L_3 by the injection at L_1–L_2, indicating that the site of puncture had sealed promptly. This absence of extravasation through the lower puncture has been confirmed in other cases (PH 946869, 852152, 079700).

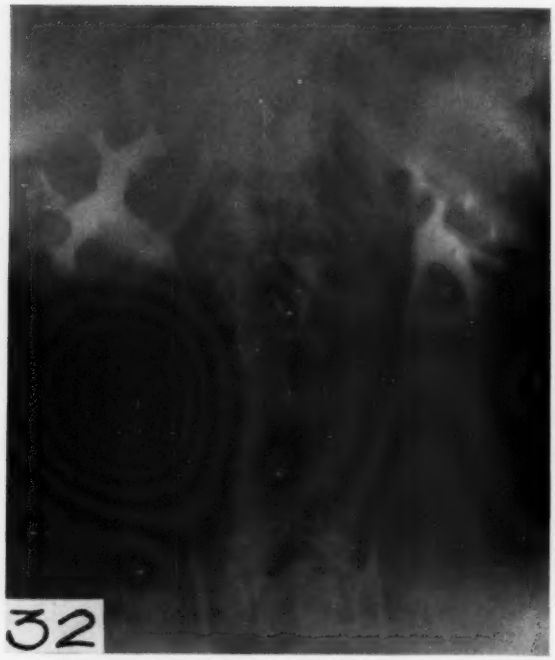
An advantage of obtaining a diagnosis of polar renal artery preoperatively in a case with pyeloureteral obstruction is that the amount of renal parenchyma supplied by that artery can be determined, as above. If the amount of parenchyma so supplied is appreciably large, dividing such an artery would, of course, be out of the question.

4. *Extent of Arterial Supply to a Kidney.* A practically nonfunctioning kidney with long-standing *perinephritis* and pyonephrosis may have a rich arterial supply with many *tortuous* arteries (Fig. 23). This kind of kidney, however, produces a weak nephrogram and this type of arterial supply can thus be considered as being the result of chronic plus acute inflammation. On the other hand, a noninflammatory hydronephrosis of long standing shows a thinning and lengthening of the main interlobular and hilar arteries and a diminution in the caliber of the main-stem renal artery (PH 024906, 951235, 315972, 031393, 790864, 997356, 013754, 941031, 892190, 077478, 727154, 101730, 084645; also Fig. 21 and 22). When the arteries are thinned out and practically atrophic no nephrogram occurs and the kidney may be irreversibly valueless. Hinman (1934, 1935, 1945) showed that the interlobular arteries are lengthened and thinned out in long-standing hydronephrosis, that the main renal artery diminishes in caliber, and that the process goes on to atrophy of these arteries. The same applies to polycystic kidneys (Fig. 69) (see also Hinman and Morison, 1924). In the case of unilateral hypoplastic kidneys (Fig. 13 and 16), the artery to the contralateral kidney is hypertrophied.

5. *The Nephrogram* is a term popularized by Hellmer (1942) to indicate the intensified renal shadow produced by the injection of the various water-soluble organic iodides which are concentrated by the kidney. Alexander von Lichtenberg had noted the intensification of the renal shadow by ordinary intravenous pyelography. Doss *et al.* (1942) have used the more extensive term "cortico-medullogram," not-

Fig. 30. PH 045759. Right renal arteriogram in a sixty year old native of the British West Indies with chyluria. There is no apparent communication between the renal arterial system and the lymphatics. No. 17 needle; 25 cc. 75 per cent neo-iopax; local procaine.

Fig. 31. PH 013754. Combined aortogram and retrograde pyelogram in a patient with congenital right hydronephrosis. The polar or "aberrant" constricting branch of the right renal artery is obvious and its existence was confirmed in the operating room. No. 17 needle; 25 cc. 75 per cent neo-iopax; local procaine.



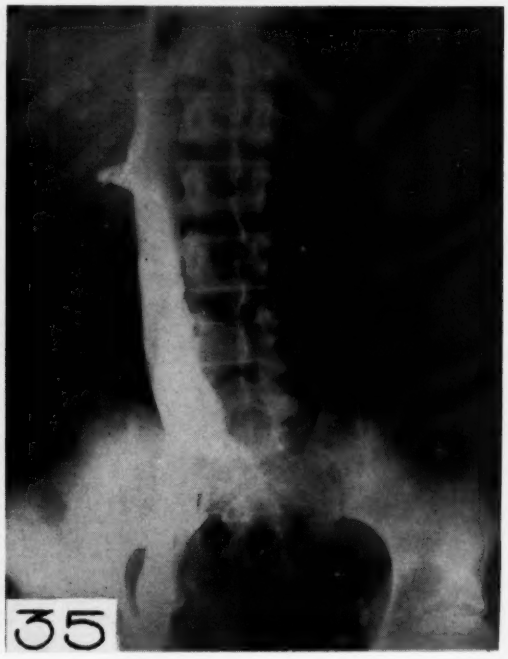


Fig. 32. PH 050863. Retrograde pyelogram. Adenocarcinoma of right kidney.

Fig. 33. PH 050863. Aortogram of same patient as in Figure 32. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. Note pooling in the right kidney extending medially over the vertebrae and superiorly indicating extension of adenocarcinoma of the right kidney, probably into the right renal vein and into the liver.

Fig. 34. PH 050863. Caval phlebogram of same patient as in Figures 32 and 33. No. 18 needle; 35 cc. 75 per cent neo-iopax; local procaine. Note practically complete obliteration of the lumen of the inferior vena cava with marked hypertrophy of the collateral venous channels; the paravertebral, hemorrhoidal, and epigastric veins. At surgery intraluminal blockage of the inferior vena cava by renal adenocarcinoma was confirmed.

Fig. 35. PH 040486. Normal caval phlebogram. Compare with Figure 34.

Fig. 36. PH 066374. Retrograde pyelogram. Twenty-four year old female. Adenocarcinoma of left kidney.
Fig. 37. PH 066374. Aortogram of the same patient as in Figure 36. No. 18 needle; local procaine; 22 cc. 75 per cent neo-iopax. Note pooling in left kidney and beyond confines of kidney, indicating extension of the renal adenocarcinoma.
Fig. 38. PH 064596. Retrograde pyelogram. Adenocarcinoma of right kidney.
Fig. 39. PH 064596. Aortogram of the same patient as in Figure 38. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. Adenocarcinoma of the right kidney diagnosed by pooling of iodide in the right kidney.

Fig. 40. PH 081769. Retrograde pyelogram. Adenocarcinoma of left kidney thought to be large solitary cyst.

Fig. 41. PH 081769. Aortogram of the same patient as in Figure 40. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. Faint pooling of iodide in the left renal mass differentiated the latter from large solitary renal cyst.

Fig. 42. PH 852152. Aortogram showing extensive pooling of iodide in the left kidney and beyond the confines of the kidney, indicating advanced adenocarcinoma of left kidney with extension. No. 17 needle; 35 cc. 75 per cent neo-iopax; local procaine.

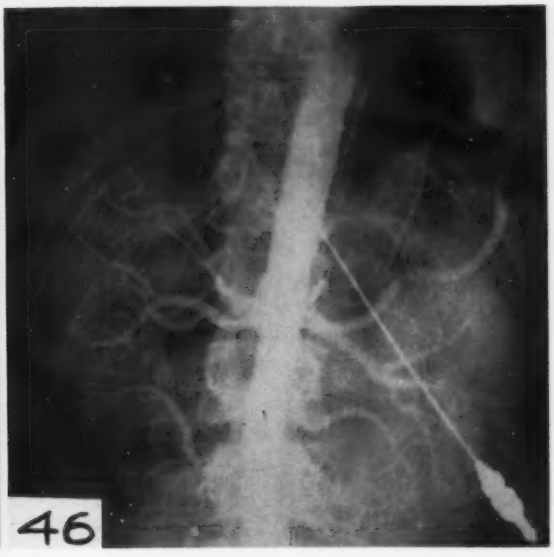


Fig. 43. PH 068931. Retrograde pyelogram of a fifteen year old boy. Adenocarcinoma or sarcoma of right kidney.

Fig. 44. PH 068931. Aortogram of the same case as in Figure 43. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. The mass in the left kidney shows no pooling but is directly invaded by branches of the intrarenal arteries.

Fig. 45. PH 072193. Left perirenal aerogram showing large suprarenal mass.

Fig. 46. PH 072193. Aortogram of the same patient as in Figure 45 done about twenty-four hours after the perirenal injection of air. No. 17 needle; 40 cc. 75 per cent neo-iopax; local procaine.

ing that the latter is more intense when 70 per cent diodrast is injected (total iodine in 20 cc. = 7 gm.) than when 80 per cent sodium iodide is used (total iodine in 20 cc. = 13.6 gm.). Even when a roentgenogram of the kidneys is taken only three seconds after beginning the translumbar intra-aortic injection, the renal shadow stands out intensely. The density of the rapidly appearing nephrogram is a good index of renal

function. In cases of congenitally dilated renal pelves and ureters it also serves to outline the extent of the renal parenchyma especially when the renal pelves exceed the areas of the nephrograms, thus indicating an extensive extrarenal pelvis (Fig. 21 and 22). Similarly, good nephrograms have been produced by rapid intravenous injection of 50 cc. 70 per cent urokon (Wall and Rose, 1951) or 70 per cent diodrast (Weens *et al.*, 1951). Theoretically, at least, equal amounts of urokon and diodrast should give more intense immediate nephrograms than neo-iopax because the first two have a much higher renal clearance rate than neo-iopax which is excreted largely by filtration (Smith and Ranges, 1938; Neuhaus *et al.*, 1949).

The first nephrograms were reported from delayed exposures and not from exposures taken during or shortly after injection (aortic and rapid massive intravenous). The nephrogram which appeared on a delayed exposure was from cases with *acute* ureteral obstruction, in whom renal function on the affected side was not markedly diminished (Wesson and Fulmer, 1932; Wilcox, 1935; Weens and Florence, 1947). Hellmer (loc. cit.), studying patients with acute renal colic by intravenous urogram recognized a cyst or tumor in the renal shadow. Leighton (1949) studied artificially produced lesions in canine kidneys by nephrography.

A kidney with an acutely or chronically obstructed ureter will, however, always yield a much weaker *immediate* nephrogram than a normal kidney (*e.g.*, Fig. 25 and 27) although the *delayed* nephrogram will be more intense if there is appreciable renal function left (Fig. 26). Ureteral obstruction of even very brief duration will diminish renal blood flow and metabolism (Levy *et al.*, 1937) and, if the intrapelvic pressure exceeds 20 mm. of mercury, will diminish renal function (Pilcher *et al.* 1937; Share, 1952) presumably by raising the renal interstitial pressure above its normal of 10 to 16 mm. of mercury (Gottschalk, 1950) and thus compressing the intertubular veins and capillaries.

6. *Obstruction of a Renal Artery.* When retrograde pyelography indicates a nonfunctioning kidney of normal or appreciable dimensions, aortography can disclose whether there is obstruction of the renal artery. Figure 19 shows no left renal artery except for a short proximal blind stump; the patient had a sudden episode of gross hematuria with blood from the left kidney and pain in the left renal region; there were no radiopaque calculi and the patient had rheumatic heart disease with auricular fibrillation. For some time, too, she had been having pain in the legs. The aortogram shows not only obliteration of the left renal artery, presumably by a detached mural auricular thrombus, but also bilateral partial occlusion of the iliac arteries, especially the right. She died at home weeks later perhaps from an embolus to the brain because she developed hemiplegia before death.

7. *Presence or Absence of a Kidney.* When retrograde pyelography and excretory urography are fruitless, aortography may be useful in establishing the presence or absence of a kidney. Six such cases were encountered. Two cases (PH 040486 and 075819) had left pelvic kidneys, that of the first being especially difficult to catheterize so that a Ravich irrigator was used to obtain a retrograde pyelogram (Fig. 17). In both cases the renal artery to the pelvic kidney arose from the caudal end of the aorta (Fig. 18). Two cases (PH 079839, 768342) had absent right renal arteries and right nephrograms; their left renal arteries and left solitary kidneys were hypertrophied. One of these cases (PH 768342) was explored; her right ureter tapered to a mere narrow fibrous strand at the cephalic end of which a few renal tubules could be discerned microscopically. One elderly man (100325) had an absent left renal artery and left nephrogram but the right renal artery and kidney were hypertrophied. He had a distinct vascular plexus in the region

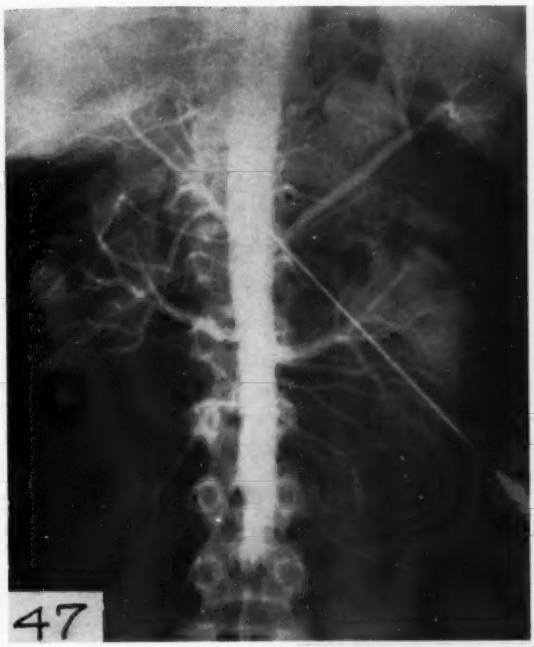


FIG. 47. PH 053326. Aortogram with body inclined head downward at 20° with horizontal. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. Note that the spleen is displaced cephalad and that the splenic artery is straightened out from the head-down position. The region between the spleen and the cephalic pole of the left kidney is thus expanded.

FIG. 48. PH 740501. Aortogram showing caudal displacement and thinning out of the right renal artery by an extrarenal mass. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine.

FIG. 49. PH 740501. Caval phlebogram of same patient as in Figure 48. No. 18 needle; 28 cc. 75 per cent neo-iopax; local procaine. Note hypertrophy of left paravertebral veins resulting from partial obstruction of the inferior vena cava at the level of the renal veins.

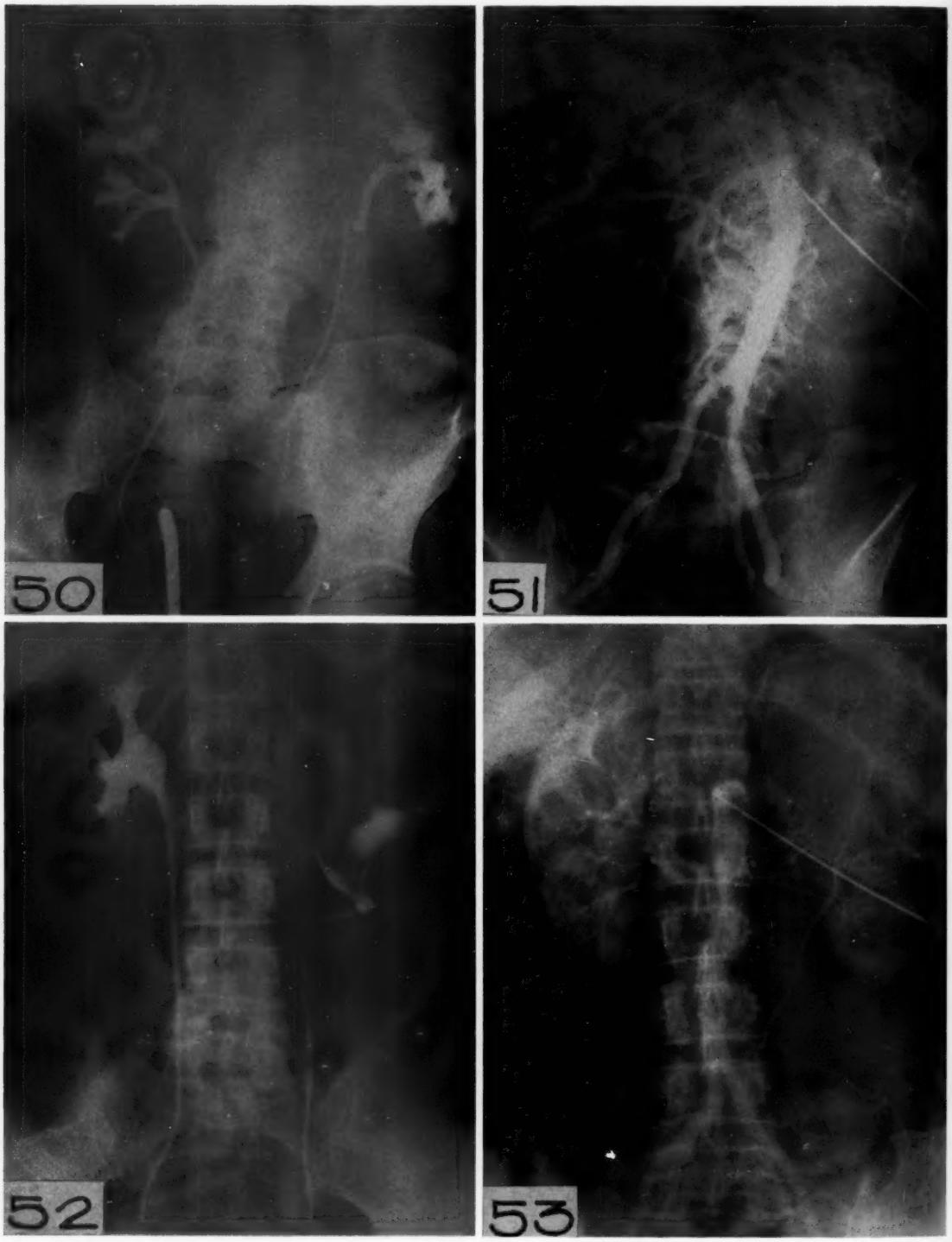


FIG. 50. PH 030563. Retrograde pyelogram.

FIG. 51. PH 030563. Aortogram of same case as in Figure 50. No. 17 needle; 20 cc. 75 per cent neo-iopax twice for stereoscopic roentgenograms; local procaine. Note clean-cut circumlocution of a cystic mass in the lower pole of the left kidney by intrarenal arteries without pooling.

of the left adrenal gland supplied by a small branch from the aorta and another from the left inferior phrenic artery. One case (PH 015664) had a single hypertrophied right renal artery and a small apparent stump of a left renal artery (Fig. 20); the left ureteral orifice leading to a markedly hypoplastic left kidney has not been seen since March, 1937, although repeated trials have been made at locating it.

The injection of oxygen into the retroperitoneum presacrally and retrorectally, after the method of Ruiz Rivas (1948)* as modified by Blackwood (1951) and D. R. Smith *et al.* (1951), may confirm the aortographic findings. This was done in P.H. 100325 using 15 cc. oxygen per kg. body weight; roentgenograms were taken one hour and twenty-four hours after the injection and satisfactory pneumoretroperitoneograms obtained.

8. *Etiology of Gross Hematuria When Other Known Methods Have Failed.* This problem has occurred in three Negro women, twenty-nine, thirty-five, and forty-two years of age (PH 023396, 026684, 987816). In PH 026684 aortography faintly suggested neoplasm near the pelvis of the superior pole of the bleeding kidney. A heminephrectomy was performed and telangiectasia of the renal pelvis found. Postoperatively, gross hematuria has recurred but the cause is now known. There have been no indications as yet for exploring the other two cases.

9. *Miscellaneous.* We have found various indications for aortography in the diagnosis or exclusion of renal disease. There was the West Indian with chyluria and occasional hematuria (PH 045759) in whom a direct renal arteriogram (Fig. 30) showed no communication between the arterial system and the lymphatics. There was the elderly woman (PH 048225) with a calcific crescent at the superior pole of the left kidney which was found to be in the wall of the splenic artery; also the case of the left nonfunctioning kidney (PH 942800) in whom an attempt at aortography produced pus through the needle as the latter was being inserted. In the last case puncture of the aorta was desisted from and incision and drainage of the perirenal abscess resulted in recovery of renal function. In another case (PH 736644) a persistent filling defect traversing the neck of a specific calyx was found to be a tortuous intrarenal artery. In a patient (PH 040459) suspected of having tumor of the adrenal cortex, the left kidney was lower than the right apparently because of a largely retroperitoneal spleen as indicated by aortography. This patient, however, was still being closely followed by the Endocrine Clinic under the directorship of Dr. J. W. Jailer.

A knowledge of the arterial supply to and within the kidney is of value in cases for which partial resection of that kidney is contemplated (*e.g.*, PH 959775 and 714403). There also is the riddle of the "Goldblatt kidney" and of Trueta's second phenomenon.

Dos Santos (1929) has remarked that aortography may be of value not only in indicating the etiology of anuria with acute renal failure but that it may also be therapeutic. No evidence has been presented as yet for this.

10. *Obstruction of the Inferior Vena Cava.* We have performed over twenty caval phlebograms. In four out of the eight with renal or adrenal neoplasm there was partial

* The first such injection in the Department of Urology at the Presbyterian Hospital was done by the senior author in a four year old boy (PH 91630) with precocious virilism. The enlarged adrenals appeared in striking relief. It cannot be overemphasized that aspiration through the indwelling needle must be performed before every single injection of gas even with the presacral route. A bloody or serosanguineous tap is the signal for unconditionally cancelling or deferring the procedure.

Fig. 52. PH 036963. Retrograde pyelogram. The left pyelogram and the dilated perirenal veins at surgery were more indicative of adenocarcinoma than cyst but the aortogram (Fig. 53) indicated cyst.

Fig. 53. PH 036963. Aortogram of same case as in Figure 52. No. 18 needle; 22 cc. 75 per cent neo-iopax; local procaine. The fine intrarenal arteries circumlocute the periphery of a "kidney" consisting entirely of multilocular multiple cysts.

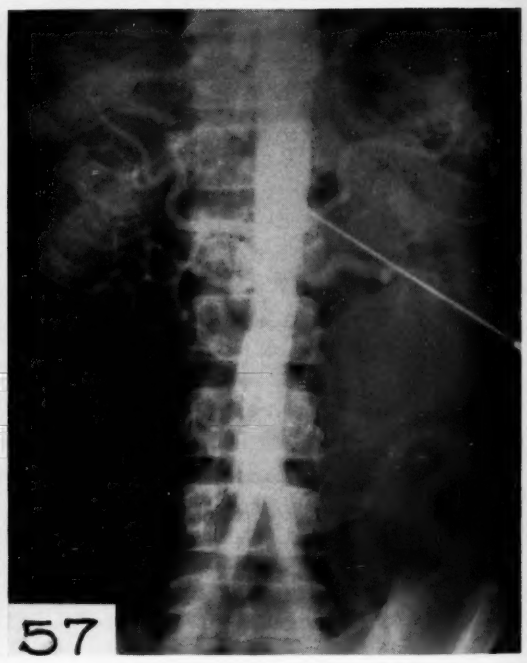


Fig. 54. PH 053794. Aortogram indicating large solitary cyst of cephalic half of left kidney. Body inclined head down at 20° from horizontal; No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine.

Fig. 55. PH 075254. Aortogram indicating large solitary cyst of cephalic half of left kidney. No. 17 needle; 30 cc. 75 per cent neo-iopax; local procaine.

Fig. 56. PH 081714. Aortogram indicating large solitary cyst of caudal half of left kidney. No. 17 needle; 30 cc. 75 per cent neo-iopax; local procaine.

Fig. 57. PH 035256. Aortogram indicating large solitary cyst of caudal half of left kidney. No. 17 needle; 30 cc. 75 per cent neo-iopax; local procaine. At surgery, the cyst broke open into the retroperitoneal space and a portion of its wall was found to consist of cystadenoma (or ? cystadenocarcinoma). Now, two years post-operatively, the patient shows no sign of malignancy.

FIG. 58. PH 016198. Retrograde pyelogram showing defect in central part of left renal pelvis.

FIG. 59. PH 016198. Aortogram showing no pooling in left kidney and a distortion of the left intrarenal arteries apparently about a spheroidal mass. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. The aortogram altered the initially contemplated transabdominal approach to one of simple incision through the left flank.

FIG. 60. PH 954291. Retrograde pyelogram.

FIG. 61. PH 954291. Aortogram indicating large cyst in the right kidney. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine. The cyst was an intrarenal abscess. Patient also had diabetes mellitus and coronary sclerosis.

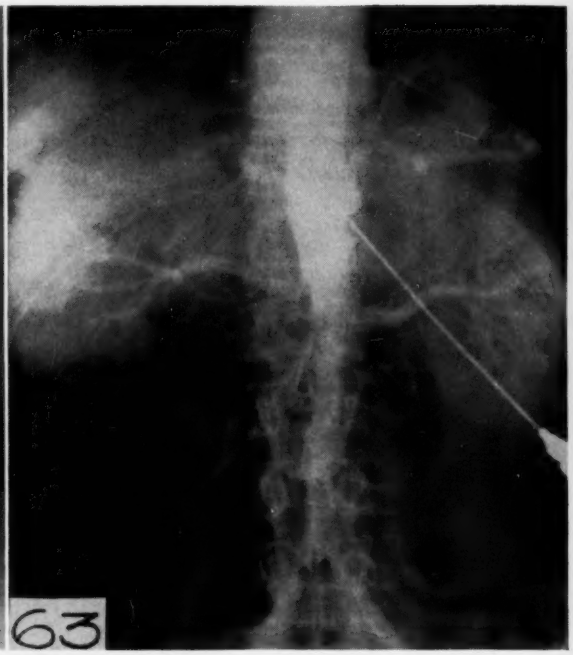


Fig. 62. PH 927274. Retrograde pyelogram showing defect in upper pole of right kidney; impression carcinoma.

Fig. 63. PH 927274. Aortogram indicating cyst in cephalic pole of right kidney. No. 17 needle; 22 cc. 75 per cent neo-iopax; local procaine.

Fig. 64. PH 025352. Left retrograde pyelogram.

Fig. 65. PH 025352. Aortogram indicating multiple large cystic spaces in left kidney rather than carcinoma, No. 17 needle; 20 cc. 75 per cent neo-iopax; local procaine.

to complete obstruction of the inferior vena cava. The systemic venous return from the lower half of the body was through hypertrophied collateral venous channels: the paravertebral, deep and superficial epigastric, and hemorrhoidal veins (Fig. 34). The

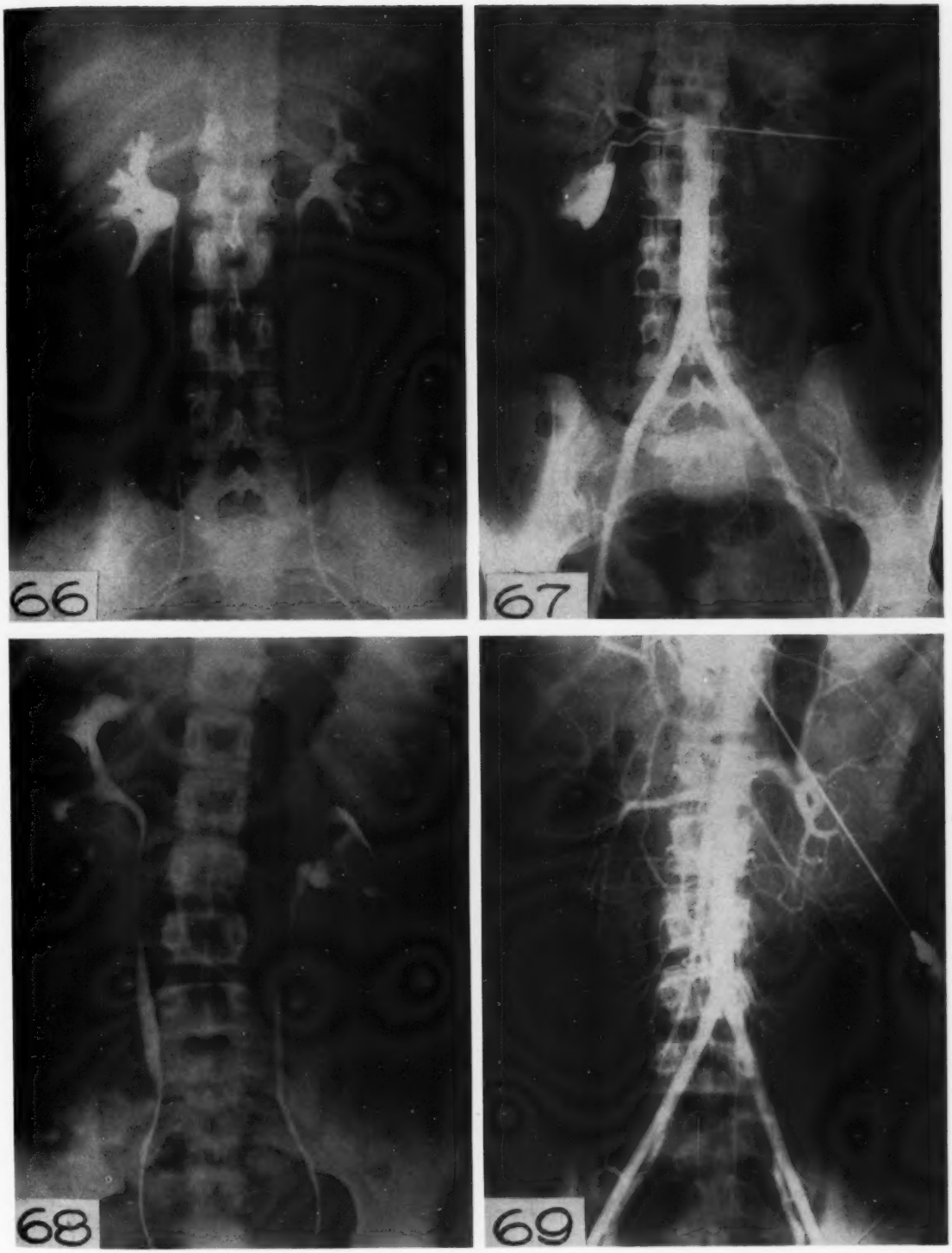


Fig. 66. PH 569489. Retrograde pyelogram indicating solitary cyst of caudal pole.

Fig. 67. PH 569489. Aortogram confirming cyst of caudal pole of right kidney. No. 18 needle; 22 cc. 75 per cent neo-iopax; pentothal. Note extravasation of iodide between renal capsule and parenchyma apparently due to inadvertent forceful injection directly into a capsular artery arising from the aorta.

Fig. 68. PH 961761. Retrograde pyelogram in a ten year old girl with bilateral polycystic renal disease.

Fig. 69. PH 961761. Aortogram in a ten year old girl (same case as in Fig. 68) showing the amply spread out intrarenal arteries and the poor nephrogram (BUN = 34 mg. per cent; PSP excretion = 40 per cent in 2 hours). The liver and spleen are apparently also polycystic, as indicated by the ample fanning out of the arteries in these viscera. No. 17 needle; 30 cc. 75 per cent neo-iopax; pentothal.

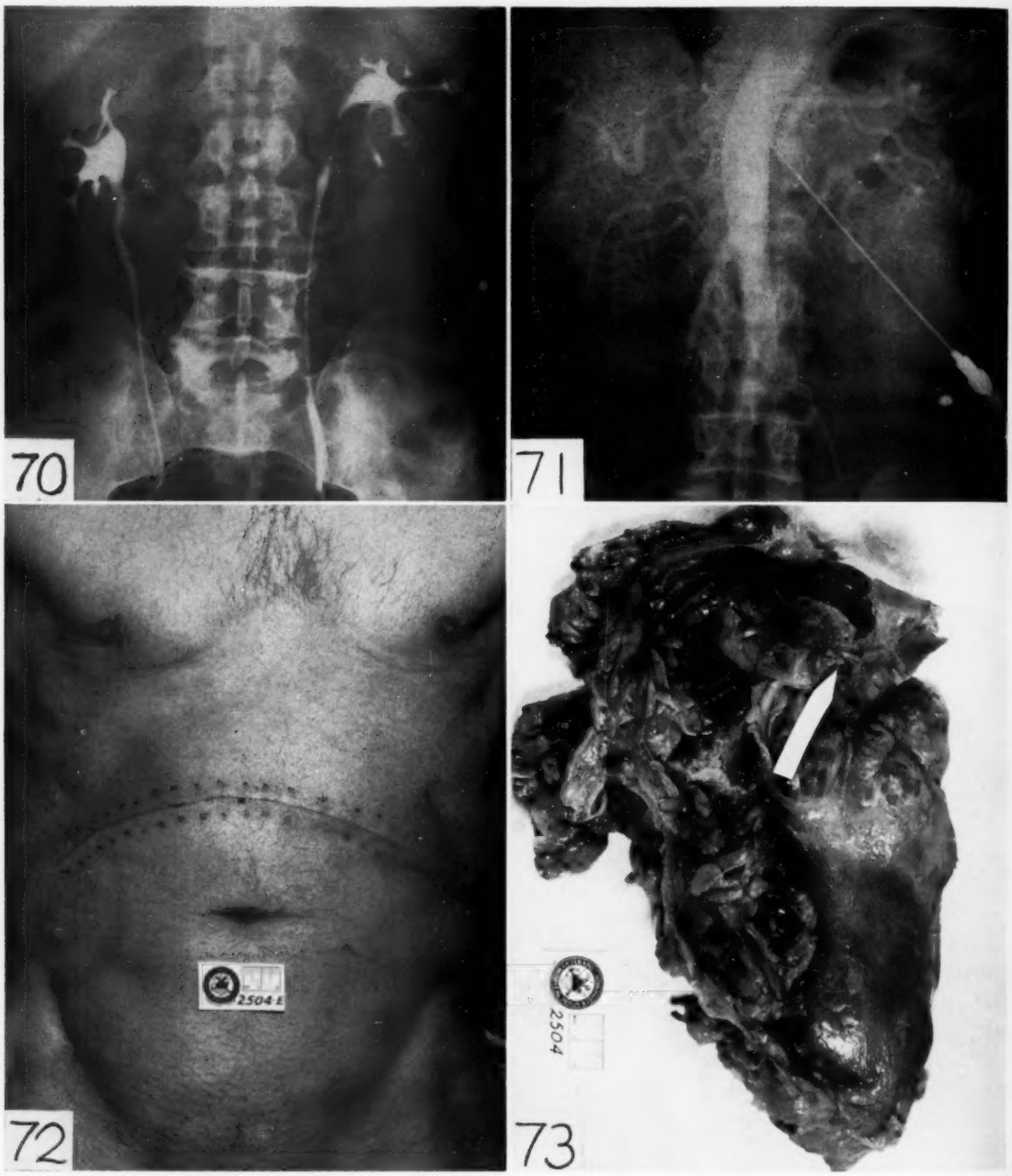


FIG. 70. Retrograde pyelogram shows deforming lesion in lower half of left kidney which may be neoplasm or a large solitary cyst. (Patient 27993, Veterans Administration Hospital, Houston.)

FIG. 71. Aortogram of same patient as in Figure 70. Pooling of iodide in growth of left kidney indicates carcinoma. No. 17 needle; 35 cc. 70 per cent urokon.

FIG. 72. Anterior abdominal wall of same patient as in Figure 70 about one week following nephrectomy. Transabdominal approach. The renal vein and perirenal veins were divided and ligated before mobilizing or handling kidney.

FIG. 73. Excised kidney with intact paranephric and perinephric fat and perirenal fascia (Gerota's). Tumor had invaded through renal capsule and into the pararenal fat (arrow) but not through the perirenal fascia. Accurate diagnosis demanding wide approach was afforded by aortography. Two years after operation (Feb., 1955) the patient feels well and has no evidence of cancer.

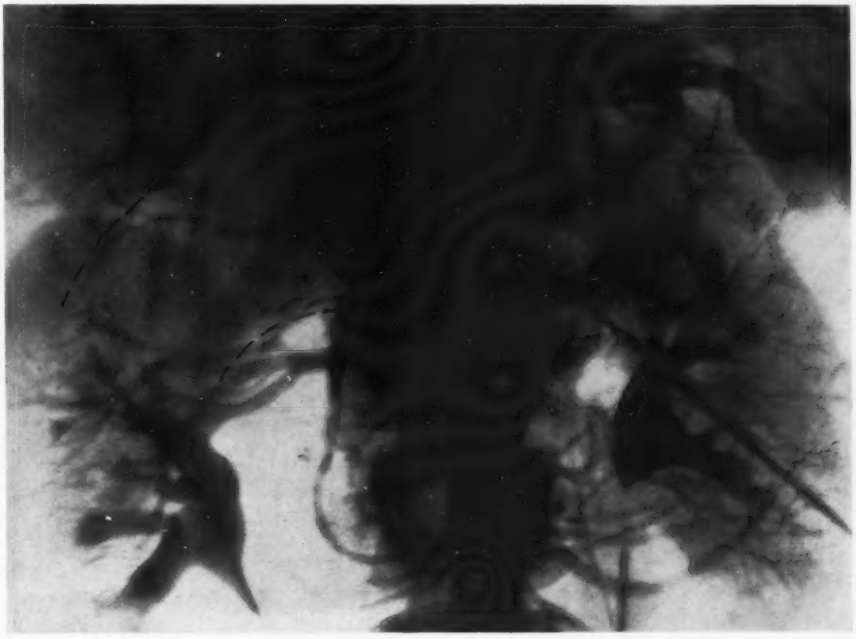


Fig. 74. Aortogram, combined with retrograde pyelogram and pneumoretroperitoneogram, of a patient (VAH 48334) with pheochromocytoma displacing upper pole of right kidney. Note increased vascularity in the area between broken ink lines; 35 cc. 70 per cent urokon; No. 17 needle with No. 16 lumen. (Performed by Dr. James S. Boren.)

hypertrophied hemorrhoidal plexus of veins thus acted as a shunt of venous flow from the systemic to the portal systems: a cavoportal shunt.

The case shown in Figure 34 had swelling of both legs not relieved by recumbency; his superficial epigastric veins were notably dilated. Edema of the legs, however, does not have to exist with complete obstruction of the inferior vena cava as shown by another case (PH 100348) with spreading renal adenocarcinoma whose superficial abdominal veins were dilated but who had no pedal edema.

It may be pointed out that marked obstruction of the inferior vena cava is not itself proof of inoperability or of vascular extension. Thus the obstruction in one case (PH 102758) was found, at autopsy, to be due solely to external pressure upon the inferior vena cava by the advanced neoplasm. Conversely, renal adenocarcinoma with extension to the spleen, diaphragm, and liver need not involve the inferior vena cava grossly (PH 852152).

In one case (PH 740501) partial intraluminal obstruction of the inferior vena cava was caused by a thrombus of undifferentiated sarcoma from both adrenal glands (Fig. 49); this was confirmed at autopsy. In another elderly patient (PH 011778) with proved simple solitary cyst of the right kidney and no renal neoplasm the right common iliac vein was completely obstructed probably, as Dr. Ralph A. Deterling, Jr., thinks, by an organized blood thrombus.

A caval phlebogram should be preoperative routine for every diagnosed adenocarcinoma of the kidney.

DISCUSSION

Since the important diagnostic discovery of dos Santos and his colleagues[68,69,70] (1929, 1931), translumbar aortography has been performed in the United States initially by Nelson (1942, 1945), Doss (1943, 1944, 1946, 1947, 1951, 1952), and Wagner (1946, 1947). Parke G. Smith and Arthur T. Evans (see above) have popularized its

use among urologists. A few deaths directly attributable to the injection have been reported. These have been caused by inadvertent injection of concentrated sodium iodide directly into the superior mesenteric artery (Wagner, 1950; Doss, 1952b; dos Santos, 1947; Sante, 1952). Melick *et al.* (1952) found that injecting a concentrated solution of sodium iodide into the superior mesenteric artery of dogs results in necrosis of the intestine, but not so with the water-soluble organic iodides including 70 per cent urokon. Parke G. Smith *et al.* (see above) have repeatedly noted that 75 per cent neo-iopax inadvertently injected into the superior mesenteric artery is apparently harmless and so have we (Fig. 1 and 2). Byrne and Melick (1951) have indicated the toxicity of 70 per cent sodium iodide injected intramuscularly in guinea pigs. Singleton (1928) and Henline and Moore (1936) indicated the toxicity of concentrated sodium iodide to the arterial intima and Henline and Moore showed how poorly the canine aorta closes over a puncture inflicted by a No. 18 or No. 20 needle. Extravasation of 80 per cent sodium iodide outside the aorta may cause a severe and long-lasting chemical neuritis of the lumbar nerves (Deterling[16]). Joyeux *et al.* (1950) blame a colocolic intussusception on the 110 per cent "Ténébryl"* used intra-aortically.

So far as we know, no deaths have been reported from the use of the water-soluble organic iodides intra-aortically.†

Possible detachment of an atheromatous plaque during puncture of the aorta has often been brought up for question. We do not know of such an occurrence even in cases with arteriosclerotic aortic aneurysm of partial obstruction. Smith *et al.*[78] report 2 cases of moribund patients injected before death. At necropsy the aortic puncture was found to be through an atheromatous plaque and there was no evidence of hemorrhage or detachment of the plaque.

* "Ténébryl" (Guerbet) is iodopyracet or "Diodrast" (Winthrop).

† The delayed fatal reaction following aortography with neo-iopax reported by Josselson and Kaplan (*J. Urol.*, 1954, *72*, 256–260), appears to have been the result of terminal pyelonephritis.

SUMMARY

1. If one uses well defined precautions, translumbar aortography with local procaine anesthesia and 70 per cent urokon or 75 per cent neo-iopax is safe.

2. The most serious complication in our series of about 250 cases was division of the thoracic lymph duct. This was due to lack of familiarity with the technique and could have been avoided if due precautions had been taken.

3. Aortography combined with the previous introduction of oxygen into the retroperitoneum has been found advantageous in the diagnosis of retroperitoneal masses, especially with stereoscopic exposure.

4. The water-soluble organic iodides are not detrimental to renal function even when the latter is markedly reduced by chronic disease. Even 80 per cent sodium iodide injected directly into the renal artery in one case did not damage the kidney, according to the evidence.

5. An immediate pharmacological response to intra-aortic injection of 75 per cent neo-iopax is prompt but fleeting fall in arterial pressure followed by rapid rise to supernormal levels, returning to normal after about ten minutes. Fluctuations in arterial pressure were practically absent with 70 per cent urokon (3 cases investigated thoroughly).

6. Electrical stimulation of the tibial nerve in the popliteal fossa of an unanesthetized young woman with normal kidneys resulted in appreciable contraction of the renal arteries. This has recently been confirmed in other cases.

7. Aortography is an important tool in differentiation between renal adenocarcinoma and cyst. The latter, however, may include adenoma (probably a precancerous lesion) or abscess, and thus warrants surgical exploration. Pooling of the iodide in the kidney indicates the necessity for wide extirpation of the kidney, if possible, without entering the perirenal fascia (Gerota's). This would not be possible if Gerota's fascia had to be entered for distinguishing between cyst and neoplasm.

8. Aortography, by showing the position

and course of the renal artery, helps indicate the readiest approach to the renal pedicle in a case with renal neoplasm.

9. Aortography can depict polar and aberrant renal arteries and indicate the amount of kidney supplied by such an artery.

10. Aortography can indicate the extent of stretch and narrowing of interlobular arteries in hydronephrotic "nonfunctioning" kidneys and thus indicate whether such kidneys are viable.

11. The immediate nephrogram following transaortic injection of the organic iodide is an index of renal function and can depict cystic areas.

12. Aortography can indicate whether a renal artery is obstructed and the presence or absence of a kidney. There are other uses for aortography in urology.

13. Obstruction of the inferior vena cava by tumor may occur from renal or adrenal neoplasms. The obstruction is usually intraluminal but may be exclusively extraluminal.

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ADDENDUM

In our one case of pheochromocytoma (V.A. Hosp. 48334) aortography demonstrated strikingly increased vascularity in the tissue apparently displacing the upper pole of the right kidney (Fig. 74). Since the pheochromocytoma is a vascular tumor such a finding may be pathognomic.

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A CRITICISM OF RENAL ANGIOGRAPHY*†

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RENAL arteriography is now an accepted urologic diagnostic aid. Since its introduction by dos Santos, enthusiasts of the technique have performed thousands of arteriograms and have described their value in the differential diagnosis of renal parenchymal and vascular abnormalities.

The random application of any new diagnostic technique to large numbers of patients within the limits of reason, of course, has certain advantages. It is obvious that the physician is permitted an appraisal of the relative safety of the procedure and at the same time is afforded an opportunity for the exploration of its scope of clinical usefulness; all within a short period of time.

At the University of Michigan renal arteriography has been employed in the investigation of 200 patients. The series represents a selected group chosen as candidates for this procedure primarily by reason of the fact that accepted methods of investigation had not given sufficient definitive information to guide further therapy, and it seemed reasonable to expect that arteriography might provide this needed additional knowledge. It is with this group that an attempt has been made to examine objectively the value of aortography and to appraise, as candidly as possible, each case primarily to determine in what way this diagnostic procedure affected the method of clinical management. For, as with any new or revised technique, comprehensive appraisal of its actual merit after adequate clinical trial is a necessity. Certainly at present it appears that renal angiography allows the physician the privilege of presumptive conclusions when confronted with the differential diagnosis of renal or retroperitoneal lesions. Certainly interesting information about the vascularity of the abdominal and retroperitoneal viscera is always obtained from angiography. This does not necessarily justify its frequent use nor allow it to be considered as a universally meritorious procedure.

It seems that a consideration of the value of the aortogram resolves itself into one of purpose. If the principal aim is an academic one and is primarily concerned with the exploration of every possible facet before submission of the patient to surgical intervention, then the aortogram truly fulfills a need. If, however, concern lies more with practical clinical management and measures merit in the terms of clinical application, then the information gained by arteriography may be less helpful. To narrow this further, perhaps it may be best to question the criteria for performance of arteriography and answer by saying that to be useful the method should provide information unobtainable by the usual retrograde or excretory roentgenographic techniques; information which might clinically alter or improve the management of the individual patient.

To permit evaluation with these criteria in mind individual cases have been selected from the group as a whole by reason of the fact that they represent diagnostic problems of such a nature that it would seem rational to expect that renal angiography would supply information of real value.

CASE PRESENTATIONS

It has been said that perhaps the one most valuable use of renal arteriography is in the differentiation of renal tumor from renal cyst. Two examples of each have been chosen for consideration.

Case 1. This man was initially seen because of hematuria and a left renal mass. The retro-

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† Presented before the Detroit Branch of the American Urological Association, April, 1954.

FIG. 1. (*A*), (*B*) and (*C*). Case 1.

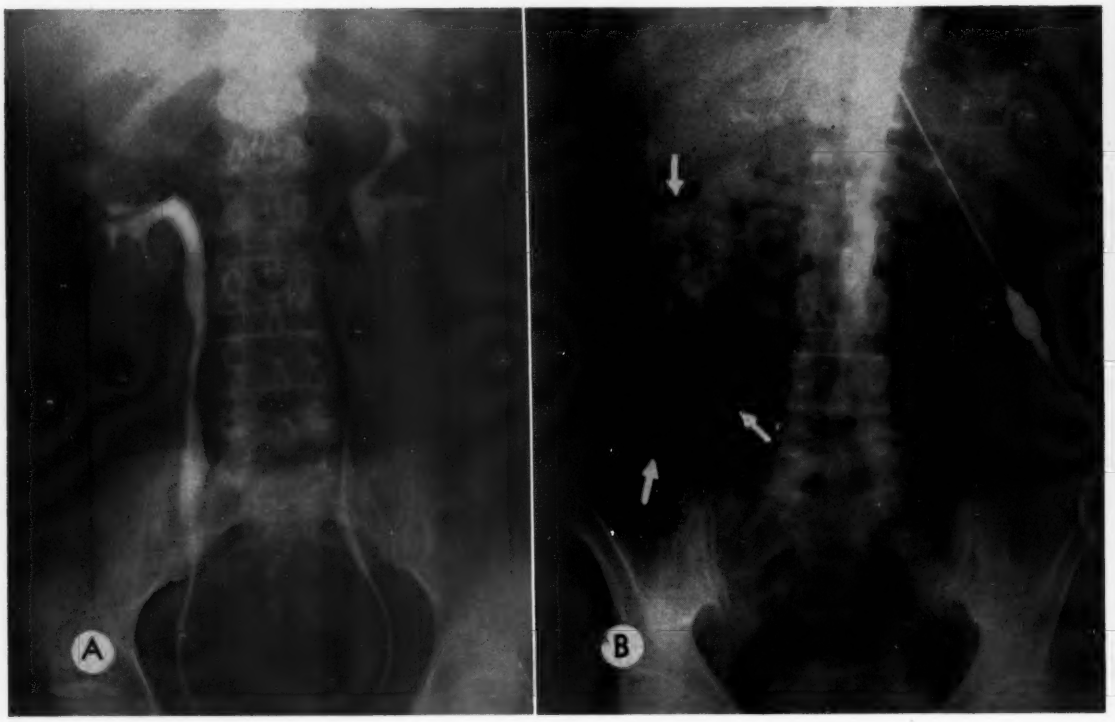

Fig. 2. (*A*) and (*B*). Case II.

grade study showed the typical tumor deformity as seen in the accompanying film (Fig. 1*A*). Arteriography was advised and a suggestion of puddling of contrast material within the suspicious tumor area was noted (Fig. 1*B*). Exploration was carried out with removal of a large hypernephroma. Figure 1*C* illustrates the roentgen appearance of the surgical specimen when injected with a contrast material postoperatively, and demonstrates well the intense vascularity of the tumor as contrasted with the arteriographic appearance. It can be said in all fairness that the aortogram failed to alter the clinical decision for exploration made on the basis of the retrograde pyelogram.

Case II. This patient gave a history of right flank discomfort with intermittent hematuria

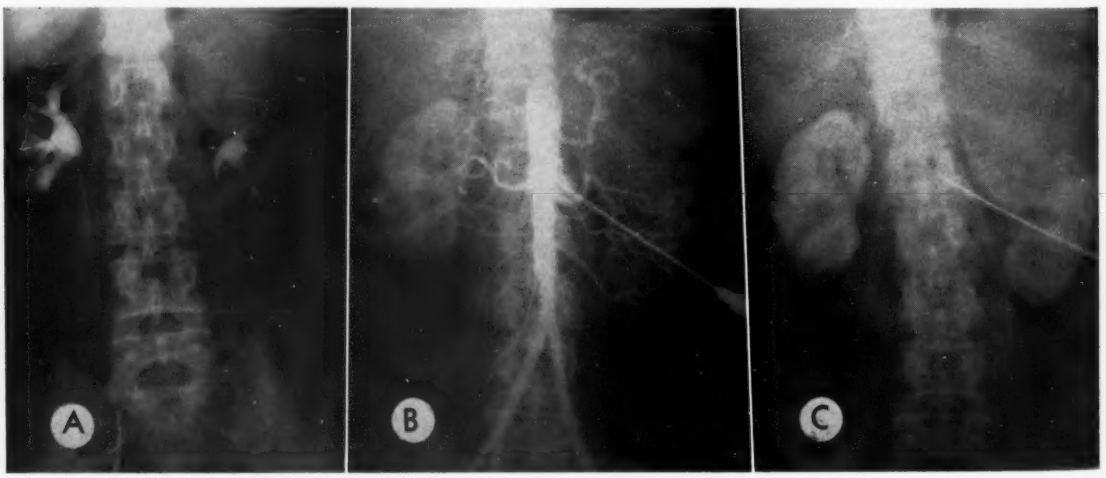

Fig. 3. (*A*), (*B*) and (*C*). Case III.

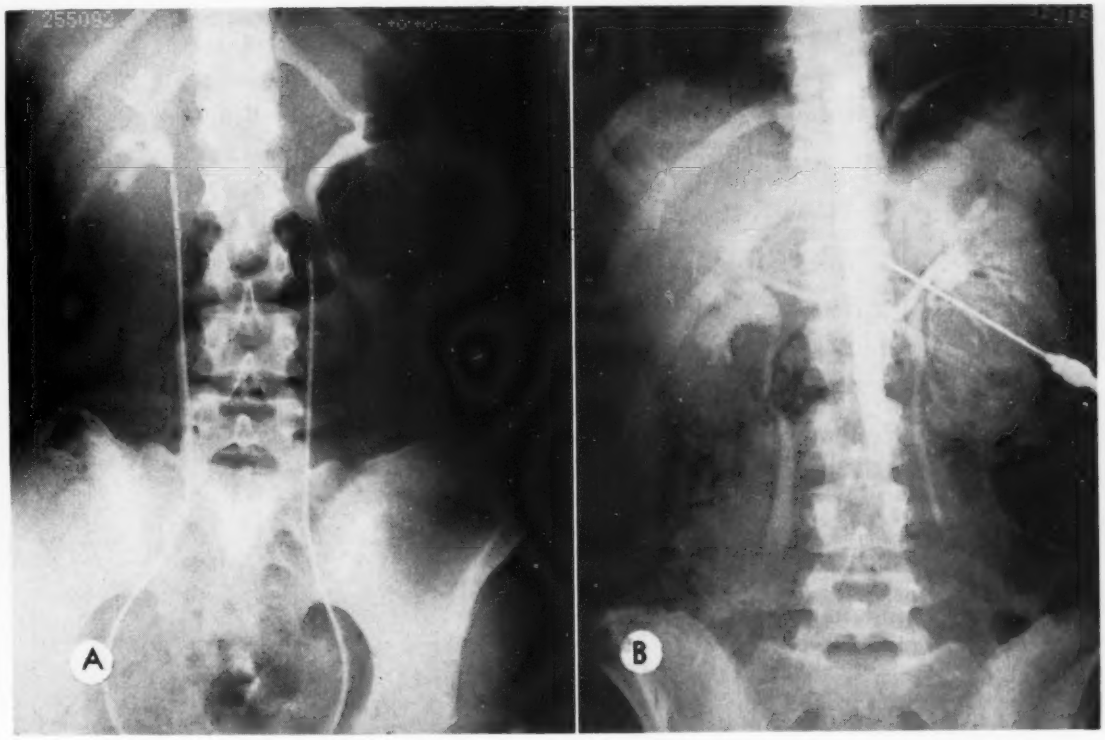

Fig. 4. (*A*) and (*B*). Case iv.

for nine months. A tumor deformity was noted in the right kidney on the retrograde pyelogram (Fig. 2*A*). The arteriogram showed some increased vascularity in the region of the upper pole of the right kidney, with an avascular area intimately associated with the lower pole interpreted as possibly representing a large solitary cyst (Fig. 2*B*). Exploration was advised and a large lower pole hypernephroma was removed. The upper pole area which had shown increased vascularity was normal microscopically. The aortogram was of no clinical aid, and by contrast was actually misleading.

Case iii. This woman was referred because of recurrent urinary tract infection for many years. A filling defect suggestive of tumor was present in the left upper pole by retrograde studies (Fig. 3*A*). Arteriography disclosed a typical cyst deformity (Fig. 3*B*). Exploration was advised because of the possibility of a tumor obstructing the upper calyx with a resulting hydrocalyx. A solitary cyst was found, and marsupialized. The aortogram was an adjunctive but superfluous procedure.

Case iv. By way of contrast, this young woman was in the first trimester of her first pregnancy when referred because of gross total hematuria. A tumor deformity was present on pyelography (Fig. 4*A*), and the question arose as to whether this was a cyst or tumor. If a tumor, then interruption of the pregnancy was to be considered along with nephrectomy. The aortogram demonstrated what was interpreted as a solitary cyst (Fig. 4*B*), and she was allowed to continue her pregnancy to term without intervention. The management of this particular patient was definitely altered by the arteriogram which was an invaluable procedure.

The use of the aortogram in differentiating adrenal lesions has been described as not entirely satisfactory. The following case illustrates such an opinion.

Case v. A patient being studied for Cushing's disease was referred for aortography. The initial injection film showed what appeared to be a low lying left kidney (Fig. 5*A*) and in the immediate (Fig. 5*B*) and late (Fig. 5*C*) nephrogram phases a tumor mass appeared to be outlined by puddling of contrast medium over lumbar vertebrae L1, 2 and 3. A later retrograde study confirmed the displaced left kidney (Fig. 5*D*), and this was interpreted as an adre-

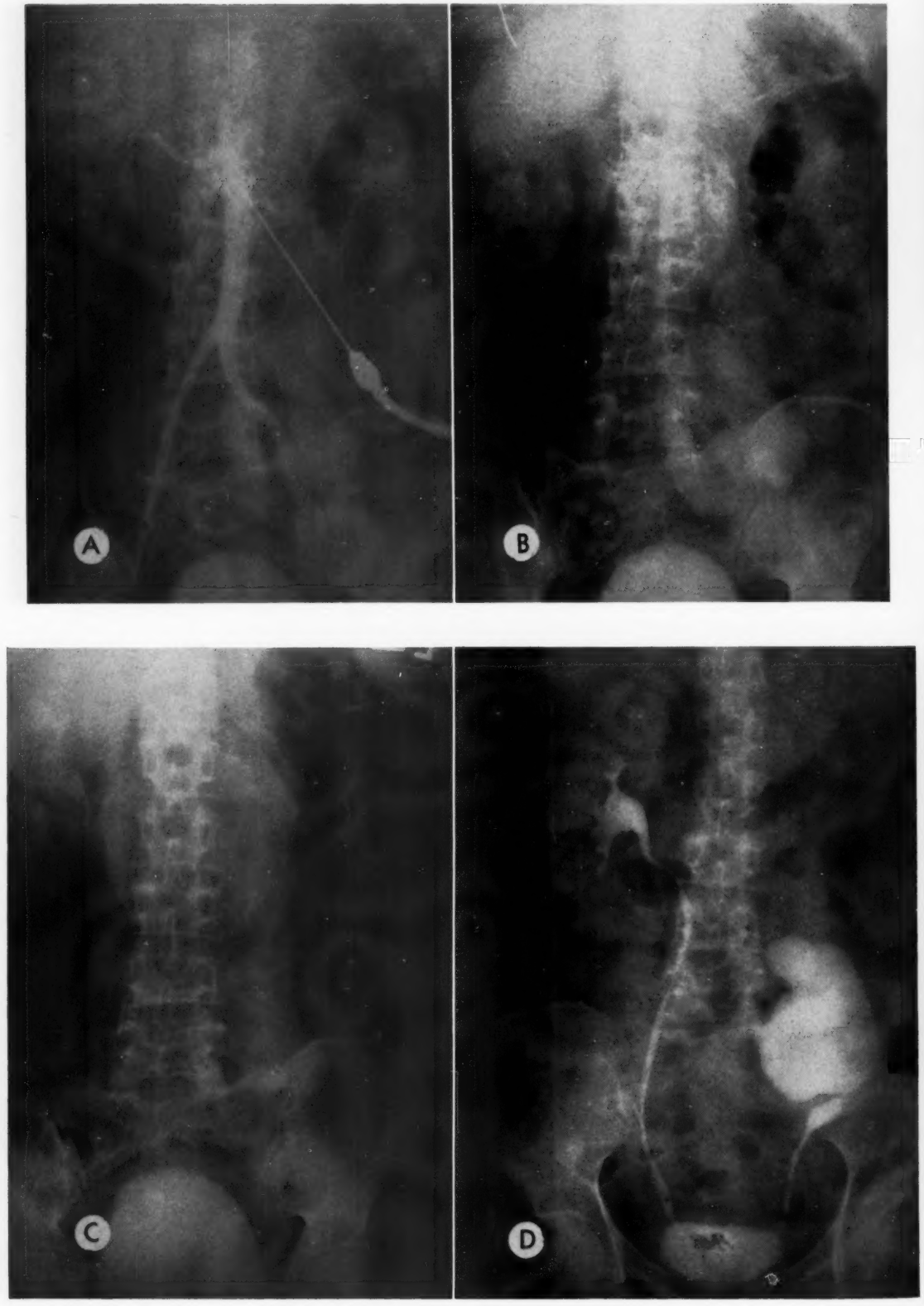

Fig. 5. (*A*), (*B*), (*C*) and (*D*). Case v.

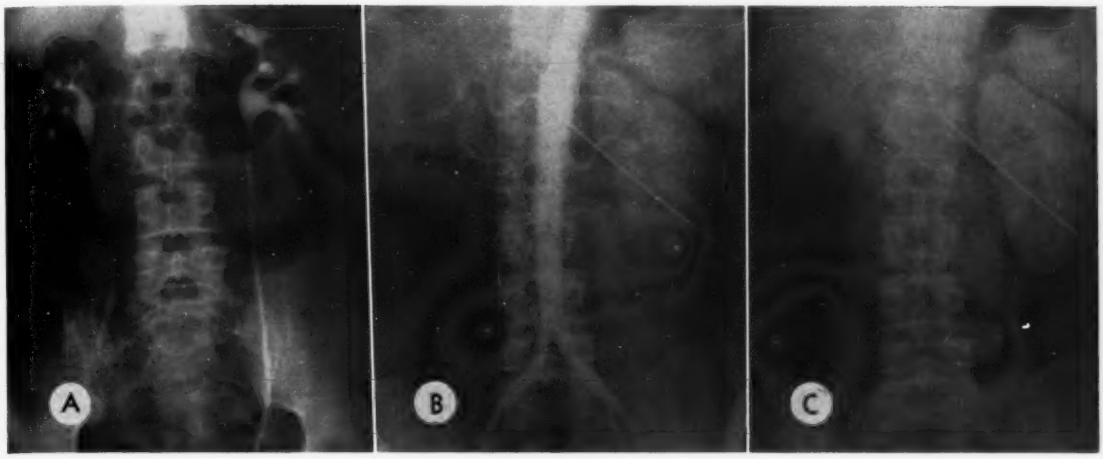

FIG. 6. (*A*), (*B*) and (*C*). Case VI.

nal tumor displacing the kidney. Exploration of the left flank revealed a normal ectopic left kidney and a normal left adrenal gland. The apparent puddling was due to extravasated contrast material at the site of aortic injection. Later exploration of the right adrenal gland was carried out and a small adrenal cortical tumor was found. This points out one of the pitfalls in diagnosis and interpretation of renal arteriograms. The aortogram was certainly a valueless procedure.

Use of renal arteriography as an aid in the diagnosis of renal hypertension has also been advocated.

CASE VI. This woman was seen because of the recent onset of moderately severe hypertension. The excretory study failed to visualize

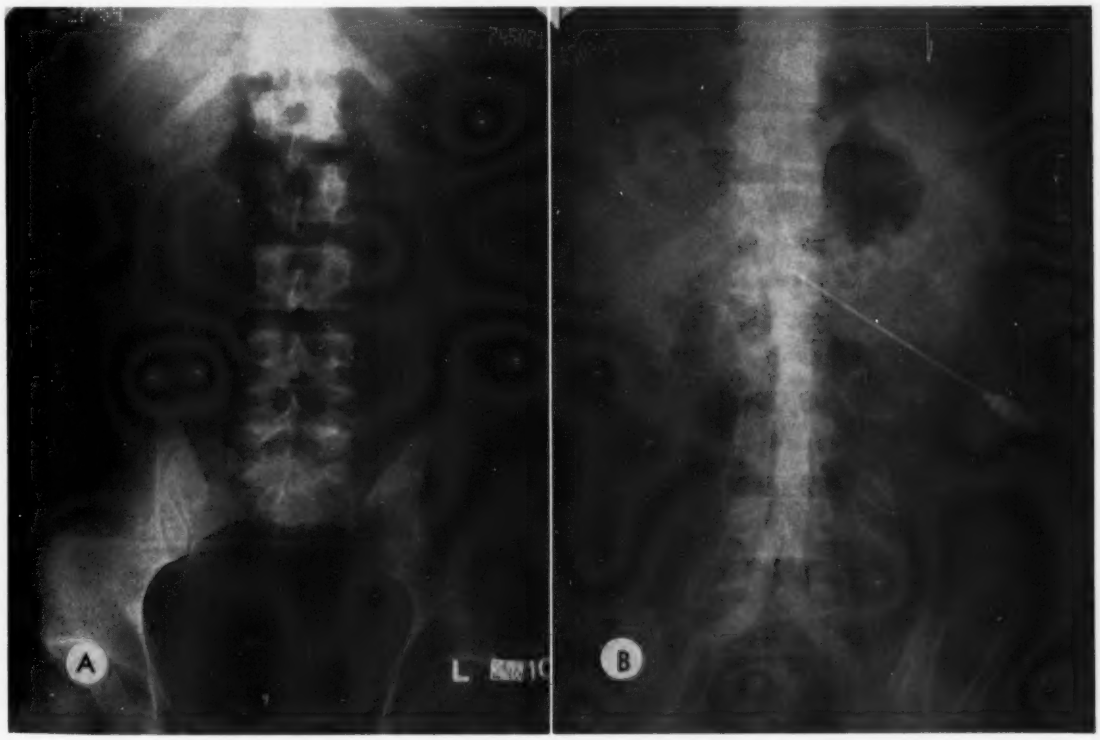

FIG. 7. (*A*) and (*B*). Case VII.

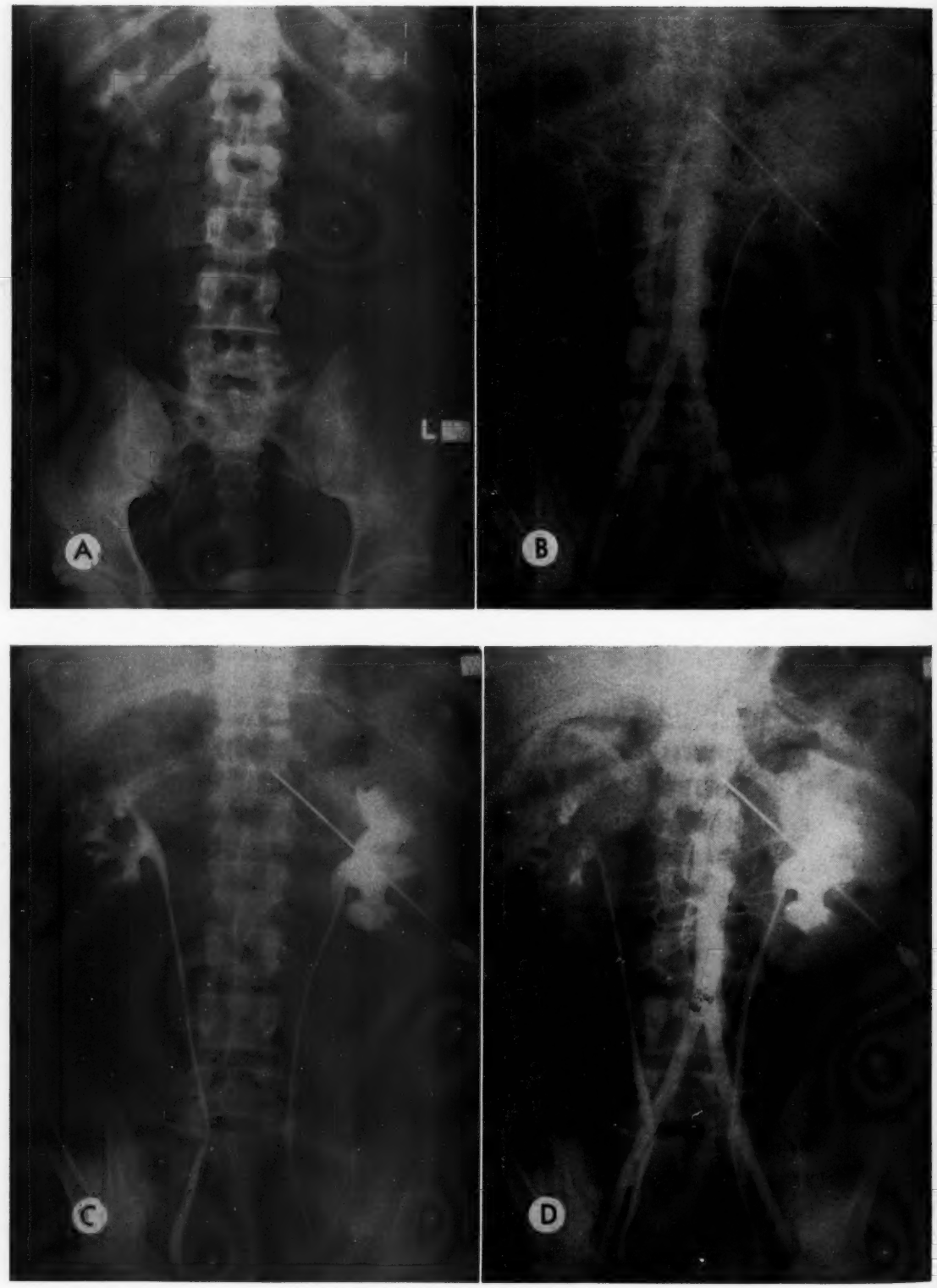

Fig. 8. (*A*), (*B*), (*C*) and (*D*). Case viii.

the right kidney but suggested a small contracted kidney. The retrograde films confirmed the impression of unilateral renal disease (Fig. 6*A*), and as an adjunct aortography was performed. It similarly confirmed the presence of unilateral renal ischemia (Fig. 6*B* and *C*), but did not actually alter the clinical management.

Case vii. This young man was also referred because of hypertension of short duration. Excretory pyelograms failed to show any indication of a left kidney (Fig. 7*A*). At cyctoscopy a left ureteric ridge was evident but no ureteral orifice could be found after a thorough search. An aortogram was carried out and a normal vascular pattern on the right was apparent but no vessels indicative of the left kidney (Fig. 7*B*). He was presumed to have a congenital absence of the left kidney, but because of his age and the severity of his disease an exploration of the left retroperitoneal space was advised after careful consideration. A tuberculous pyelonephritic kidney of moderate size was found in the normal position densely bound by inflammatory scar tissue. The aortogram again failed to provide the necessary information.

Aortography is said to be a great aid in the diagnosis of polycystic disease.

Case viii. This patient was similarly being studied because of hypertension, and the excretory pyelogram disclosed a bizarre calyceal pattern (Fig. 8*A*). Polycystic disease was suspected but a tumor could not be ruled out, although bilateral renal tumors in a young man would be exceedingly rare. A combined retrograde and arteriographic study was made (Fig. 8*B* and *C*), and the presumptive diagnosis of polycystic disease was made on the basis of the large relatively avascular areas throughout the parenchymal pattern bilaterally (Fig. 8*D*). It would seem that the arteriogram was of benefit in this case in establishing a diagnosis which could only be suspected, yet again, the clinical management was little altered.

DISCUSSION

The limitations of aortography when applied clinically are illustrated in this presentation. Selected patients with known pathology were subjected to arteriography in attempts to obtain significant information which would aid in the decisions regarding their treatment. The aortogram failed to furnish information which altered the normal course of events with few exceptions.

The differentiation of renal tumor from renal cyst is almost always demonstrated by arteriography with accuracy. Nevertheless, it is usually the accepted policy to expose such lesions surgically, and under such circumstances the aortogram becomes a redundant procedure. The possibilities of needle aspiration for renal cyst, as advocated by some, have not been explored in this clinic. Recently Dr. Willard Goodwin of Los Angeles presented an excellent discussion of this subject and perhaps his work will provide an added stimulus to this technique of diagnosis.

Arteriography for adrenal disease has been disappointing. It must be realized that the limitations on adequate interpretation and technique of performance are many. Ideally, one would prefer to visualize only the renal or adrenal circulation and avoid filling the other branches of the abdominal aorta. This is practically impossible with the translumbar route. It may be that percutaneous femoral artery catheterization with a polyethylene catheter to the renal artery level will provide a method for greater accuracy of interpretation and diagnosis. Goodwin has found this approach to the problem of adrenal angiography combined with oblique projections to be very valuable.

In our experience, renal angiography has been practically of no benefit in the investigation of patients with renal hypertension. The axiom that a kidney is only as good as its blood supply is a valid one. However, an accurate appraisal of the blood supply may often prove to be very difficult. Simple introduction of the needle near the renal artery for aortography and injection of contrast material are known to produce arterial spasm and could conceivably be quite misleading in the interpretation of the aortogram when applied to a study for unilateral renal ischemia. Certainly the visual demonstration on roentgenography of the larger vessels of the vascular bed is at best a gross and inac-

curate estimate of total blood supply to an organ. Renal physiologists accurately measure renal blood supply in terms of renal function. Clinicians can do likewise by measuring renal function in terms of glomerular filtration rate with creatinine or urea clearance tests. In this clinic the "split-creatinine" clearance test for estimating individual kidney function has proved infinitely more valuable than renal angiography in studying patients with hypertension of renal origin.

The arteriogram would seem to be valuable for the patient with polycystic disease where surgical intervention for diagnosis is imminent. It would appear also to be an aid in dealing with intrinsic structural anomalies of the renal vessels as encountered in renal fusion, fused ectopia and aneurysm. The adept surgeon, however, will continue to rely on his skill in dissection at the operating table in dealing with these difficult problems.

SUMMARY

It would appear from our experience that only in isolated, carefully selected instances, is one justified in utilizing renal angiography, as it is often an unnecessary and frequently a redundant procedure. Certainly its indiscriminate use is to be deplored. In support of this view one has but to recall that the aortogram:

1. Subjects the patient to a general anesthetic, which is not without risk.
2. Adds a burden of additional expense to the patient.
3. Often fails to provide significant information which alters our treatment of renal disease.

No attempt has been made to present the favorable aspects of the procedure as they have been previously elaborated in detail in the literature. Emphasis should be placed on certain specific values of aortography.

1. Its worth has been proved in selected cases where a differential diagnosis is of primary importance.
2. It is of immense value to the general surgeon in dealing with peripheral vascular disease.
3. It is excellent as an academic aid for investigation.
4. It provides us with pictures which are quite pleasing to our esthetic sense.

Although arteriography has obvious shortcomings as a diagnostic procedure of aid to the urologist, there is no doubt that it is firmly established as an adjunct to investigation. The cases presented are not cited to condemn the procedure as a whole but to point out the necessity for more careful selection of patients subjected to this method of survey. If one can say in advance that the investigation will be a deciding factor in the choice of a method of management, then the end justifies the means. If this is not so, then there seems little justification for its performance.

It is a hope that this discussion will lead to a more practical and realistic approach to the use of renal angiography.

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PREOPERATIVE DIAGNOSIS OF PERICARDIAL CELOMIC CYSTS

A CASE REPORT

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THE English literature contains reports of the successful removal of 62 pericardial celomic cysts. Since this lesion is uncommon and since the first was successfully removed as recently as 1934 by Pickhardt, the problem of preoperative diagnosis has not been extensively considered. Although the roentgen aspects of this lesion have been described, most authors conclude that positive differential diagnosis requires thoracotomy.

The following case is recorded to add to the roentgen literature an additional pericardial celomic cyst studied both roentgenologically and histopathologically and to draw attention to a diagnostic procedure which permitted diagnosis before thoracotomy.

EMBRYOLOGY AND PATHOLOGY

Lambert and others believe that pericardial celomic cysts arise from persistence and failure of fusion of one of the multiple disconnected mesenchymal lacunae which normally merge to form the pericardial celom. They are of simple structure grossly and microscopically, being unilocular with very thin transparent walls and not communicating with the pericardial cavity. They are loosely attached by areolar tissue and filled by thin, clear, rarely serosanguineous fluid low in protein and high in salt content.

DIAGNOSIS

To make a diagnosis of pericardial celomic cyst on the clinical symptoms that are present is not feasible for these symptoms are not pathognomonic. Symptoms vary widely from patient to patient and include pain in the shoulder, epigastric discomfort, cough, palpitation, dyspnea, or most commonly, precordial pain. The pertinent point, however, is that one-third of the patients with this lesion have no symptoms at all. Physical examination, electrocardiography, and ordinary laboratory aids are not helpful except in a negative manner and preoperative diagnosis rests primarily on roentgen examination.

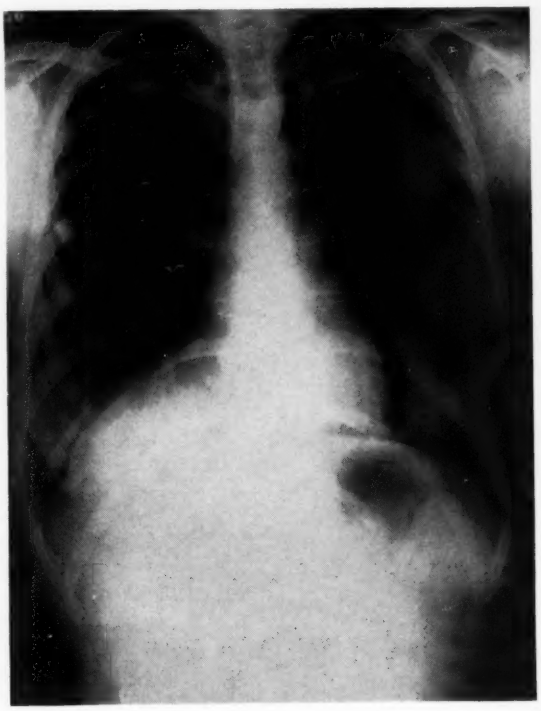

FIG. 1. Erect posteroanterior roentgenogram. Homogeneous mass at right base, sharply delineated from the lung but merging with the heart and diaphragm.

Nine out of ten of the cysts occupy the anterior cardiophrenic angle and their roentgen appearance is usually a rounded,

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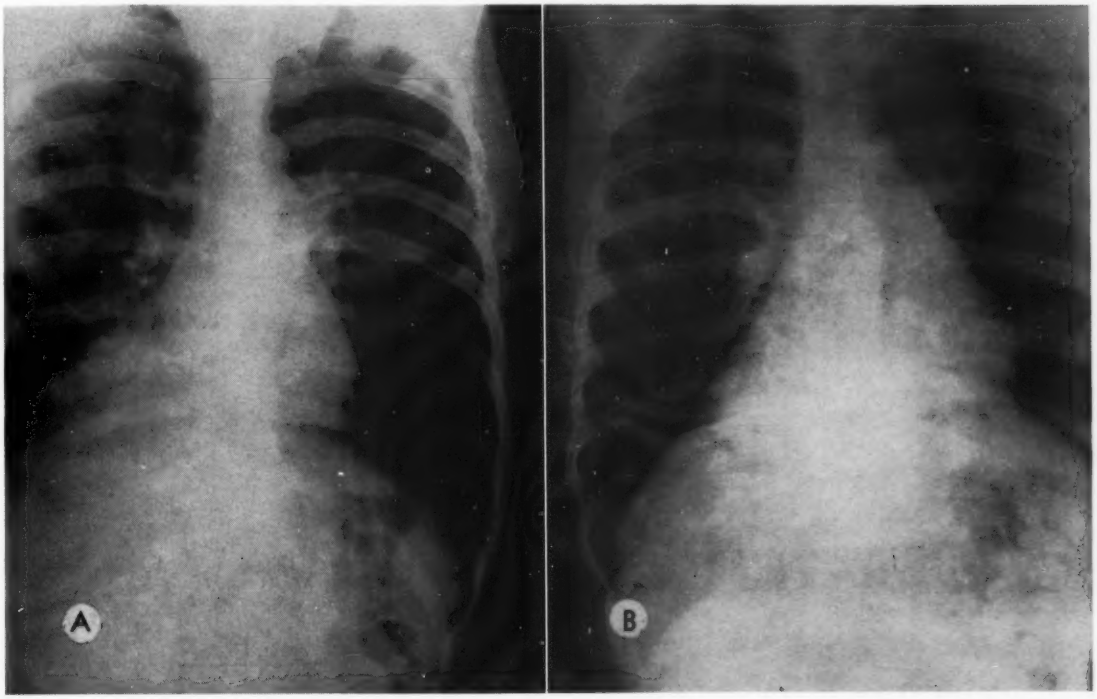

Fig. 2. (*A*) Right lateral decubitus projection. Free border of the mass convex and bulging, giving the impression of a tense cyst. Note change in shape between this appearance and opposite decubitus. (*B*) Left lateral decubitus projection. The free superior border is no longer rounded but flat and straight. Mass seems slightly smaller.

well demarcated, homogeneous shadow where it is away from the heart. The cardiac border may or may not be distinct from the shadow of the lesion but usually it is inseparable from the heart and pericardium in all planes of roentgenoscopy. The shape of the cyst may change during the phases of the respiratory cycle. There is no change in size with change of position to the Trendelenburg and decubitus positions. There is no pedicle shadow as may sometimes be seen in pericardial diverticulum. Transmitted pulsations may be noted. Angiocardiography will exclude cardiac dilatation or aneurysm.

CASE REPORT

A white female, aged twenty, had an abnormal shadow discovered in the chest during a routine chest roentgen examination at another hospital. Six months later she elected to be hospitalized to determine the cause of this lesion and to receive treatment. The usual studies were accomplished and were normal except for the shadow in the roentgenogram of the chest (Fig. 1). The initial chest film revealed a large, homogeneous, well defined shadow of increased density in the right cardiophrenic angle at the level of the diaphragm. The mass seemed encapsulated, sharply delineated from the adjacent lung tissue, but merged with the cardiac silhouette and the right leaf of the diaphragm. Roentgenographic examination in the decubitus positions showed marked change in the shape of the lesion. With the lesion dependent, its free borders were more convex and bulging, giving the impression of a tense cyst (Fig. 2). In the opposite decubitus with the lesion higher than the heart, the free superior border was flatter and straight and no longer seemed tense.

Roentgenoscopically the mass could not be separated from the heart or diaphragm, and it exhibited pulsation synchronous with the cardiac beat. This was believed to be transmitted pulsation. Motion of the diaphragm was normal, and the lesion descended with the contracting diaphragm with little apparent change in shape. There was no appreciable change in the mass on executing Valsalva or Müller exercises.

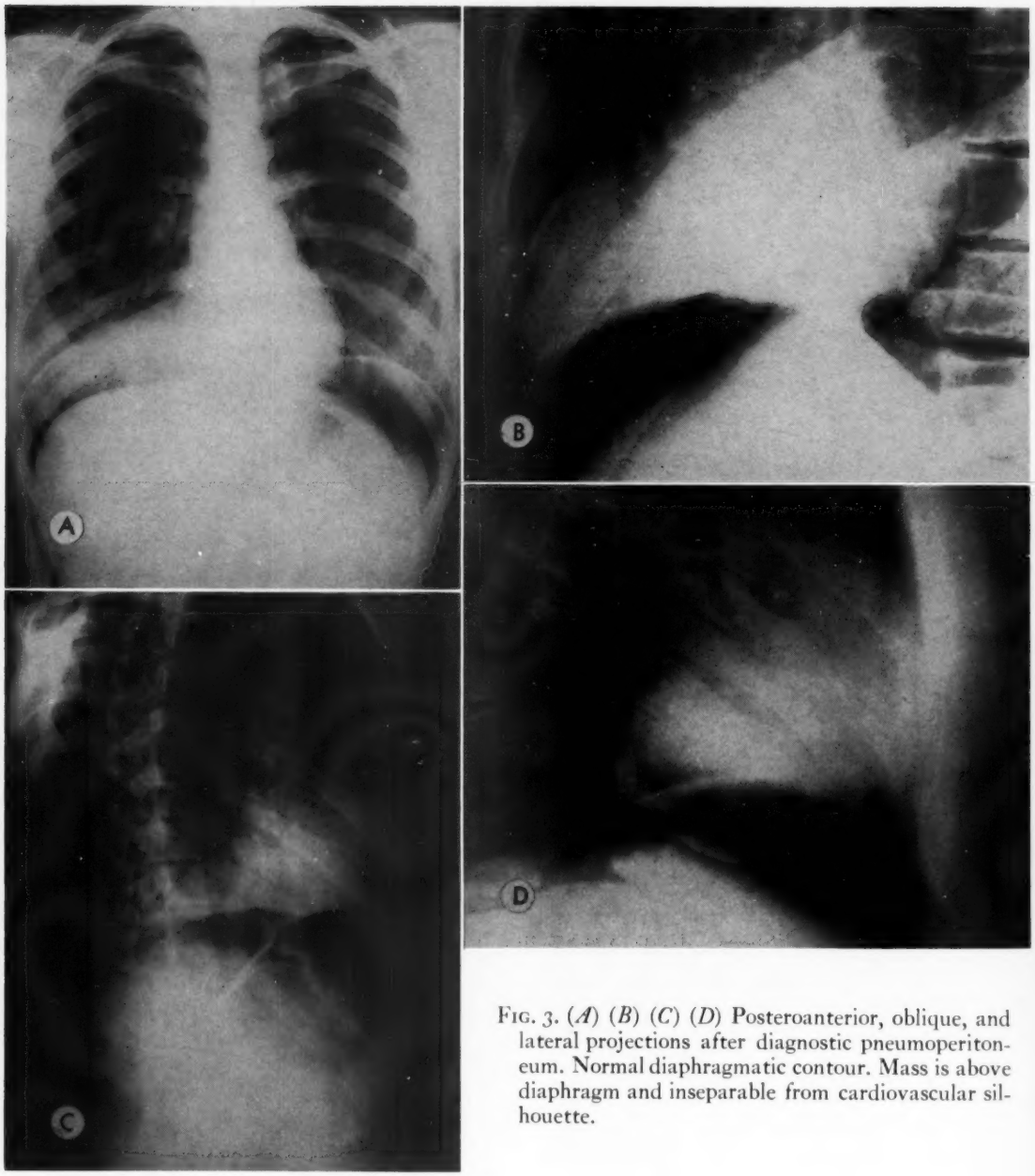

Fig. 3. (*A*) (*B*) (*C*) (*D*) Posteroanterior, oblique, and lateral projections after diagnostic pneumoperitoneum. Normal diaphragmatic contour. Mass is above diaphragm and inseparable from cardiovascular silhouette.

Barium meal and enema examination of the esophagus, stomach, small and large intestine were normal.

Because the diaphragmatic surface of the mass was inseparable from the diaphragm, a pneumoperitoneum was done for visualization of the undersurface of the diaphragm (Fig. 3). The findings were normal. The intrathoracic position of the lesion was thus established and diaphragmatic hernia, eventration of the diaphragm, and diaphragmatic cyst or tumor were excluded. It would be expected that these lesions would deform the undersurface of the diaphragm. The smooth circumscription, homogeneity, lack of lobulation, and the marked change in shape of the density when position was changed was interpreted as evidence of a fluid-filled, probably unilocular, lesion. Its location suggested pericardial diverticulum (pericardial hernia) or pericardial cyst.

With mild sedation and local anesthesia a No. 19 gauge needle was introduced into the mass. The roentgenoscopist had outlined the area where the mass presented to the anterior chest wall. Sixty cubic centimeters of colorless, crystal clear fluid were withdrawn and replaced by an equal volume of air.

Roentgenograms revealed the lesion to be unilocular, very thin walled, and not in communication with the pericardial cavity (Fig. 4). Chemical examination of the fluid revealed a chloride content of 126 mEq. (737 mg. per cent), total protein of 0.28 gm. per cent and sugar of 21 mg. per cent. A preoperative diagnosis of pericardial celomic cyst was made.

At operation, the incision was made in the 4th interspace anteriorly. Opening the chest revealed a cyst whose dimensions were 10 by 6 by 4 cm. and filled with a mixture of air and fluid. The cyst was very thin walled. It was attached to the pericardium on the right anterior surface of the heart. By means of blunt and sharp dissection, it was removed intact except for the needle hole which resulted from the aforementioned preoperative diagnostic procedure. There was no obvious preoperative leaking of fluid from the cyst, and the single needle hole proved that no tearing of the sac had occurred during the needling. The patient's postoperative course was uneventful. The lung was expanded before the patient left the operating room, and it remained that way (Fig. 5). Personal communication with the patient five months after discharge from the hospital reveals that she has no symptoms, feels perfectly well, and has a normal chest roentgenogram.

Fig. 4. Erect posteroanterior projection after diagnostic needle puncture of mass and fluid aspiration with air replacement. The paper-thin cyst wall was visible on the original roentgenogram. The unilocular nature of the cyst and its lack of communication with the pericardium were demonstrated by examination in all positions (erect; both lateral, prone and supine decubiti; and inverted).

Fig. 5. Appearance of chest after surgical removal of pericardial celomic cyst.

DISCUSSION

Jansson first suggested that if a shadow, inseparable from the heart shadow, changed with the phases of respiration then the shadow was that of a cyst. Lam has remarked on the change of shape of pericardial celomic cysts with the phases of respiration. This finding is inconstant. The more tensely filled the cyst, the more constant is the shape of its shadow. The absence of this

finding in our case was probably due to the splinting of the cyst by the broad surface of the hemidiaphragm. We did note a change in the shape of the shadow with change in position of the patient (see Fig. 2). Mazer suggested and Loehr demonstrated positional change of shape and size in pericardial diverticula. Loehr's case was unproved. Change in configuration with change in position has not been reported in pericardial cysts although changes with respiratory cycle have been emphasized. We believe that this finding has the same value in excluding a solid tumor as the respiratory change noted by others. The change in shape coincidental with change in position that was noted in the case we report was so marked as to suggest actual change in size of the lesion. Pericardial diverticulum was considered, but air contrast studies excluded this diagnosis when none of the air could be introduced into the pericardial sac by careful positioning of the patient.

The danger of fluid spillage at the time of needle aspiration is not present. To tear the wall of the cyst would not harm the patient and would only result in making the cyst somewhat less easy to remove.

Advantages of aspiration and air contrast are that these studies give two types of information presumably pathognomonic of pericardial celomic cyst. The first is the typical "spring water" type of fluid. The second is the outline of the cyst cavity as defined by the air. By roentgenographic studies in the erect, decubitus and inverted positions, all walls of the lesion can be studied as silhouetted by the contrast material and the surrounding lung. We demonstrated a unilocular cyst, paper-thin walls, with no tumor in the wall, no communication with the pericardial sac, and complete filling of the sac with thin clear fluid. These findings excluded lymphangiomatous cyst, pericardial diverticulum, inflammatory pericardial diverticulum, dermoid or teratoma, cystic hematoma, and neoplastic cyst.

Although the presence of a tumor in the thorax is usually an indication for thoracotomy, to know all possible about the lesion prior to surgery is good medicine and increases the safety of the patient. For this reason, it is felt that the simple aspiration of these lesions and the injection of air or oxygen is interesting and informative.

SUMMARY

1. A proved case of pericardial celomic cyst was diagnosed preoperatively by the technique of aspiration and injection of air. Laboratory study of the fluid and contrast roentgenography of the cyst gave the diagnostic information.

2. This procedure is believed to safely permit the accurate differential diagnosis of this lesion before thoracotomy and should prove useful in changing the axiom: The diagnosis of this benign lesion requires thoracotomy.

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PRIMARY NEUROSARCOMA OF THE HEART

REPORT OF A CASE

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IT IS the general consensus that tumors seldom occur in the heart; but if the medical literature is carefully reviewed many reported cases can be found. Metastatic tumors are present in 20.2 per cent of the hearts of patients who died of cancer.[16] Burke[5] found them in 4.3 per cent and Stout[19] could find 15 secondary tumors for every primary one. But even disregarding those metastatic tumors, primary tumors of the heart are more frequent than is generally thought.

In reviewing the literature, Straus and Merliss[20] were able to find 163 primary heart tumors reported up to 1945. This figure seems incomplete as Yater[23] had already reported 200 cases in 1931. Mahaim,[14] who has made a careful and thorough review of the subject, consulting 1,298 papers published up to 1945, found 413 cases not including 56 cases that he considered as organized thrombi or as pseudomyxomas.

This large number means that reporting a new case would be of no interest were it not because of its special histopathologic type, not found in the literature I have been able to consult. Besides benign tumors we can find reports on angiosarcomas,[7,21] rhabdomyosarcoma,[3,4,9,12] sarco-epithelioma,[1] spindle cell sarcoma,[22] leiomyosarcoma,[6] fibromyxosarcomas,[1,10,17] endothelial sarcomas,[7,8] hemangio-endothelial sarcoma,[11] lymphoid or round cell sarcoma,[15,18] myxosarcoma,[20] giant cell sarcoma,[4] celotheliomas,[2,14] but not a single case of neurosarcoma.

REPORT OF CASE

The patient in whom the tumor was found was a man nineteen years old (record No. 22089 from the Instituto Nacional de Radium, Bogotá, Colombia). Family and personal history was noncontributory. He was admitted to the hospital because of dyspnea, cough and pain in the left side of the thorax, of two months' duration.

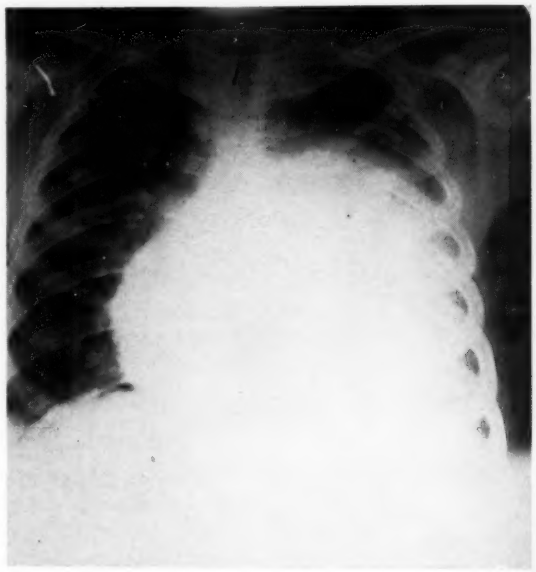

FIG. 1. Roentgenogram of the chest one month before admission. Note the sharp outline of the tumor.

One month before admission he was examined in another hospital. The roentgen report was as follows: "A very dense and homogeneous shadow covers the lower two-thirds of the left lung; its upper limit is convex and projects on the fourth posterior costal interspace. A thin ribbon of normal lung tissue can be seen between the outer aspect of this shadow and the thoracic wall. Mediastinum, trachea and the right outline of the heart are greatly deviated to the right. The cardiophrenic angle is free and pulsations can be seen at the right side. The right auricle is much enlarged" (Fig. 1). He was given high and prolonged doses of penicillin and streptomycin without any improvement. Suspecting a thoracic tumor he was transferred to the Institute.

Physical Findings. Weight, 42.5 kilograms. Patient looks gravely ill, dyspneic (40 respirations per minute), cyanotic and with seizures of dry cough and sometimes bloody sputum;

area of cardiac dullness enlarged, without special beatings of the point; 110 pulsations per minute. Blood pressure, 110/60. No murmurs could be heard. Engorgement of the veins of the neck and the anterior wall of the chest was present. The liver was slightly enlarged and tender. Clinical findings indicated a small left pleural effusion; tapping gave 200 cc. of serohemorrhagic liquid and its centrifugate showed red and white blood cells and some other atypical cells impossible of classification. Blood cell counts, blood sugar, nonprotein nitrogen, serum proteins and serum chlorides and urine test were normal. Electrocardiogram disclosed only sinus arrhythmia, without any block or abnormal pattern.

Several diagnoses were suggested: mediastinal tumor (endothelioma of the pericardium, malignant lymphoma, teratoma), bronchiogenic carcinoma and pericarditis with effusion. No bronchoscopy or bronchography was done because of the strong deviation of the trachea.

It was decided to prepare the patient for exploration. Penicillin and streptomycin were given parenterally, and intratracheal spraying of penicillin. Roentgen therapy of the mediastinum was also started as a diagnostic measure

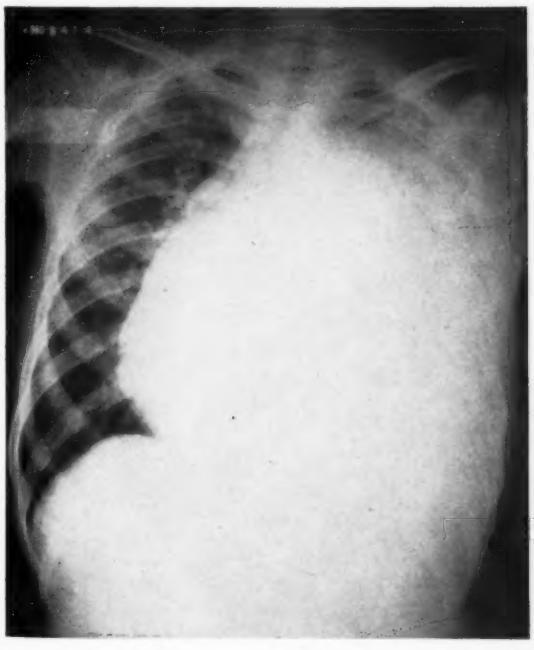

Fig. 2. Roentgenogram one month after admission and fifteen days after a tumor dose of 1,526 r, given as a test. The tumor appears even larger than before.

Fig. 3. The tumor with its strongly vascularized envelope. The atelectatic left lung can be seen at the left lower corner.

to rule out malignant lymphoma; he was given a tumor dose of 1,526 r in fourteen days (245 kv., 15 ma., 2 mm. Cu plus 1 mm. Al filter, 2.5 mm. Cu half-value layer, and 50 cm. focus-skin distance).

One month after admission the temperature was normal, dyspnea and cough had slightly subsided, but roentgenographic examination showed the thoracic mass enlarged and a left pleural effusion (Fig. 2). Blood and urine tests were normal.

No special change was observed during the

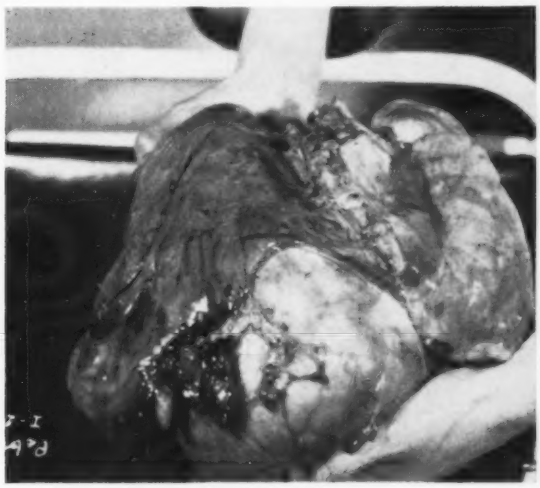

Fig. 4. The posterior and superior aspect of the tumor. Complete atelectasis of the left lung, partial of the right, and aortic arch can be seen.

Fig. 5. The superior aspect of the tumor, to show the trachea and great vessels (aorta and pulmonary artery and veins) surrounded by neoplastic tissue. Through the opened aorta a twisted rope has been passed.

sixty days following admission, and it was decided to operate. The left thoracic wall was opened through the fifth, sixth and seventh ribs. A huge tumor was found, filling almost all the thoracic cavity, with complete atelectasis of the left lung. The peripheral layers of the tumor were in direct continuity with the great vessels and many newly formed veins were present over its surface. Tapping of the tumor was done and bloody liquid obtained. The pathologist reported "epithelial-like cells" in the smears of this liquid and the surgeon considered it impossible to extirpate the tumor and closed the chest wall again.

The patient grew more ill every day with increasing dyspnea and cyanosis and died five days after the operation.

At necropsy a large ovoid tumor was found in the mediastinum, filling the whole left thoracic cavity and part of the right one. It measured 35 by 22 by 25 cm. and weighed 7,800 gm. It was covered by a membrane 1 cm. thick with multiple enlarged vessels on its surface (Fig. 3 and 4). Pericardial cavity was virtually filled, the cardiac sheath being fixed to the outer one in one actual mass. A gelatinous-like substance filled the space between the inner pericardial sheath and the myocardium, and in some places it was so thick that the cardiac walls were compressed, completely occluding the auricles. At the posterior aspect of the heart the tumor actually formed the walls of the ventricles, including the septum; the endocardium was eroded and lost in some scattered areas. The tumor mass involved the great vessels, especially the aorta and pulmonary arteries (Fig. 5, 6, 7 and 8). The right lung was in partial atelectasis against the posterior wall of the thorax; the left lung was reduced to a small mass against the tumor.

The pathologist reported the microscopic findings as follows: "The normal structure of the myocardium is in wide areas replaced by a malignant tumor whose cells are small, spindle like, with homogeneous cytoplasm and ovoid and hyperchromatic nuclei. These cells show different arrangements: in a diffuse way,

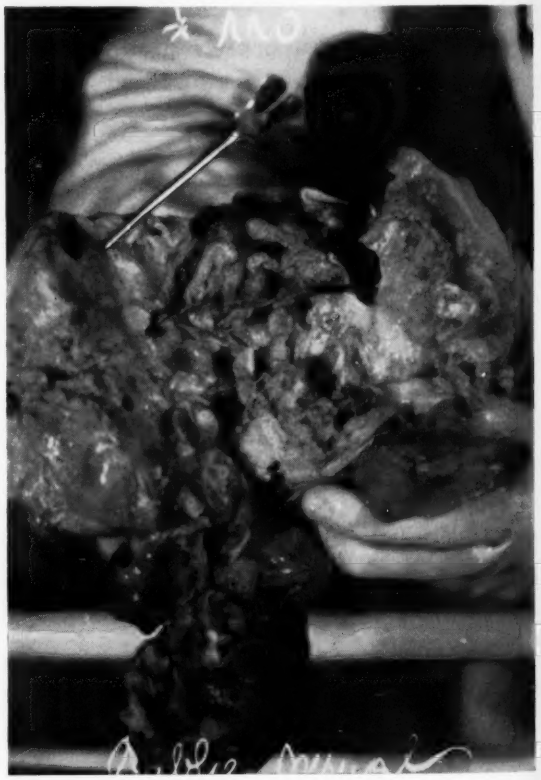

Fig. 6. Section through the left auricle; there is no cavity, except the auricular appendix (marked by the catheter).

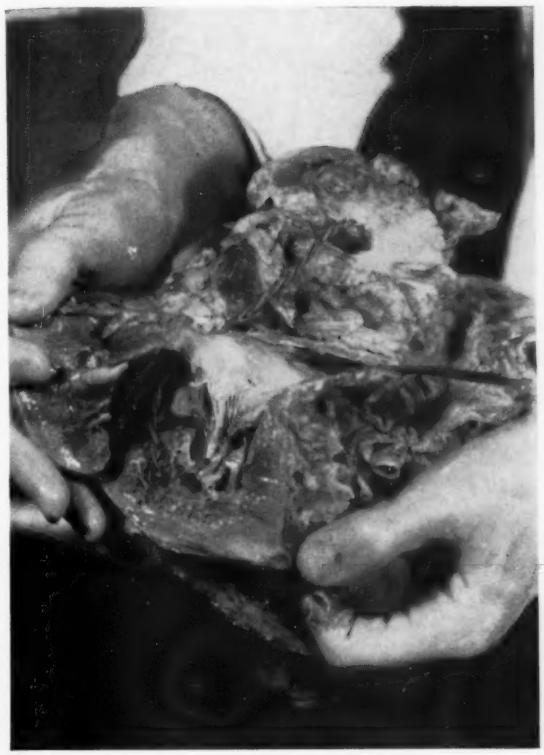

Fig. 7. The left ventricle is opened through its anterior wall; this wall and the mitral valve appear normal.

Fig. 8. The right ventricle opened. Its walls are formed by the tumor itself. The twisted rope comes in through the vena cava (left lower corner) and goes out through the pulmonary artery.

or in whorls, or in palisades. Atypical mitosis and bizarre forms are frequent. The neoplasm is very cellular and there are many blood vessels without their walls; areas of necrosis are present (Fig. 9, 10 and 11). Conclusion: Neurosarcoma of the heart."

No metastasis could be found in the lungs, liver, adrenals, spleen, brain or lymph nodes.

DISCUSSION

This is an unusual case not only because of its histological type, perhaps derived from the nervous cardiac plexus, but from some other points of view.

First, its size, 35 by 22 by 25 cm., and 7,800 gm., is larger than all other described cases. For instance, Lubschitz's case,[13] a hemangio-endothelial sarcoma, weighed with the whole heart only 295 gm. The fibrosarcoma mentioned by Woll and Vickery[22] in a woman aged forty-seven weighed, with the complete heart, 310 gm. The rhabdomyosarcoma described in a boy fourteen years old by Leach[12] weighed 350 gm. The angiosarcoma mentioned by Tacket[21]

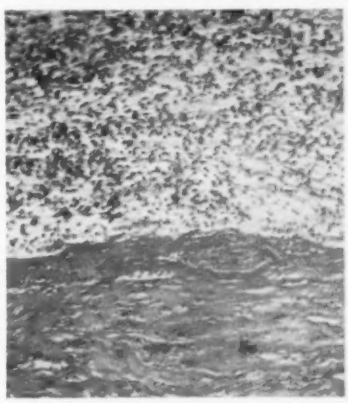

Fig. 9. Low power view. The tumor is at the upper half and normal myocardium at the lower.

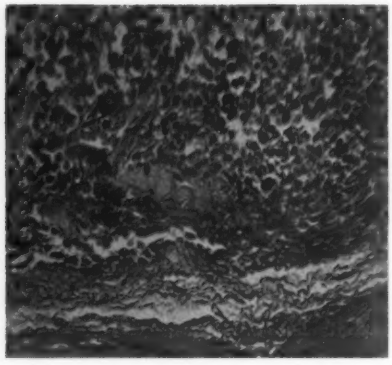

Fig. 10. The tumor cells have begun to infiltrate the myocardial fibers.

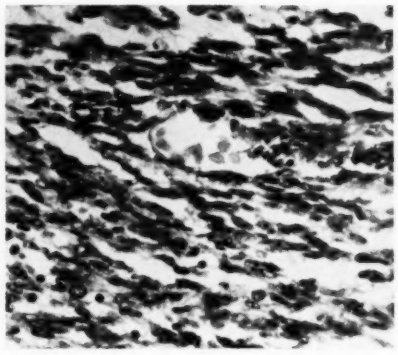

Fig. 11. High power view. Small spindle shaped cells, with hyperchromatic and irregular nuclei, with indirect mitosis and many bizarre forms. A vessel without part of its wall can be seen.

in a woman forty-eight years old weighed 640 gm. Anderson's[1] case, a myxosarcoma in a fifty-three year old woman, weighed 790 gm. Poujol[15] found in a man, aged twenty-two, a lymphosarcoma of 820 gm. Hargrove[9] mentions a rhabdomyosarcoma in a forty-three year old woman, without specification of weight but with the following diameters: 25 by 18 by 15 cm. Any one of these tumors is much smaller than the neurosarcoma we have described.

Lack of symptoms of cardiac failure is also striking, and even more, the electrocardiogram did not disclose bundle branch block, or nodal rhythm, while the tumor had destroyed the auricular walls and part of the septum. This is an indication of its origin in the extrinsic cardiac plexus and not in the conduction system.

Even if no positive diagnosis could be made while the patient was living or during the thoracotomy, a cardiac tumor was suspected, and authors agree in the difficulty of diagnosing a cardiac tumor. This is a very important point to note because palliative treatment can be given, either by surgery or by radiotherapy in some cases.

Another curious feature in our case is the absence of metastasis, the tumor being so large and with the endocardium eroded.

SUMMARY

We have presented the case of a primary tumor of the heart in a man, aged nineteen, which was suspected by clinical examination, even without signs of cardiac failure and with an almost normal electrocardiogram. The tumor was resistant to a test dose of roentgen radiation, and it was so large that excision was impossible. Necropsy and histopathological examination revealed a neurosarcoma, 35 by 22 by 25 cm. in size, 7,800 gm. in weight, and without metastasis.

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CECAL DIVERTICULUM*

REPORT OF A CASE DIAGNOSED BY ROENTGEN RAY AND SURGICALLY PROVED; REVIEW OF THE ORIGINAL LITERATURE

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CECAL diverticulitis is an uncommon lesion discovered accidentally by the surgeon, who having entered the abdomen for a supposedly acute appendicitis, encounters this entity. Herewith is presented a case diagnosed preoperatively by roentgen ray and surgically proved. The original literature is reviewed.

CASE REPORT

A fifty-nine year old male was readmitted to the Medical Service of the Veterans Administration Hospital, Fort Wayne, Indiana, October 3, 1952, with a chief complaint of vomiting. He was released following a prior admission for a questionable cardiac decompensation in June of the same year. He got along well for awhile, then developed episodes of vomiting and retching, worse when he was nervous. Vomiting dates back to 1947 and vomitus consisted of food and bile but was never bloody or fecal. Black stools were reported following bismuth medication, but not otherwise. He had lost 50 pounds in weight since 1947.

Physical examination revealed a tall, asthenic white male in subacute distress but not acutely ill. He was alert and cooperative. Head and neck were essentially negative with the exception of small pupils which, however, reacted to light and accommodation. There was marked arcus senilis. Thyroid and lymph glands were not palpable. Temperature, pulse and respiration were within normal limits. Blood pressure was 106/88.

The abdomen was soft. A small lobulated mass was felt in the cecal area, tender to palpation. There was a right indirect inguinal hernia and a relaxed ring on the left. The prostate was enlarged and nodular. Pedal edema and varicosities were absent. Neurological examination was essentially negative.

Roentgenoscopically, a lesion was seen emanating from the cecum which, on palpation, produced nausea and the patient vomited once on the table. Films revealed a loculated chamber measuring 5 cm. in its greatest diameter. Its inner wall was coated with barium and gave the appearance of being pencilled in, as if in a drawing, leading to the impression that the chamber was occupied by a fecalith. This chamber was connected with the cecum by a neck approximately 5 cm. long. Its mucous membrane resembled terminal ileum (Fig. 1). A week later, the diverticulum was still seen with the barium more evenly distributed within the fecal mass (Fig. 2).

In the differential diagnosis an ectopically placed Meckel's diverticulum and a sacculation incidental to an unusually deep haustral marking were considered. Figure 3 shows just such a sacculation.

Hospital course of the patient was benign. He vomited on several occasions, including once on the table during roentgenoscopy while palpating the lesion. Two out of three stool examinations were positive for occult blood. He was generally afebrile though his oral temperature was over 99°F. on several occasions and over 100°F. once. His white blood cell count was 8,800 with 19 per cent band forms. His remaining laboratory examination was essentially negative.

Patient was transferred to the Surgical Service where, after adequate preparation and under spinal anesthesia, a diverticulum originating from the medial aspect of the cecum about 1 cm. distal to the ileocecal valve was found and excised.

Pathological report by Dr. Louis A. Schneider

* Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

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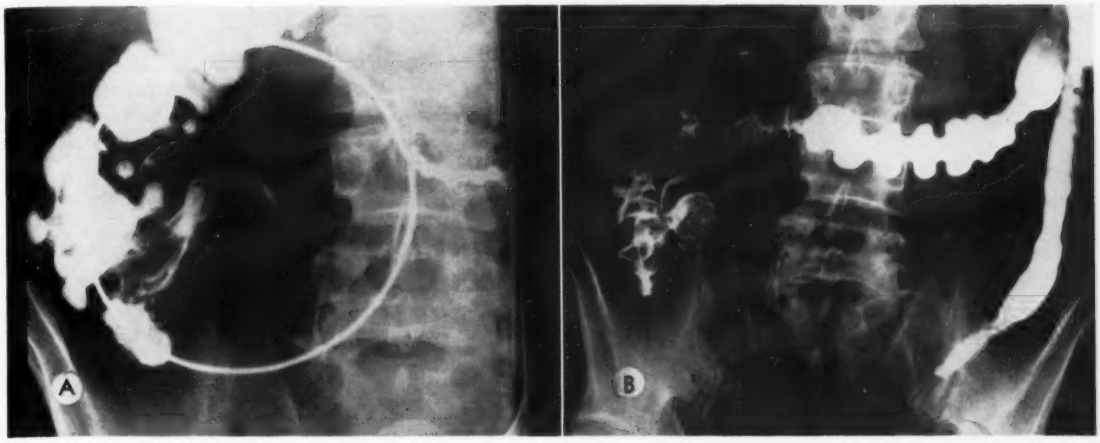

Fig. 1. (*A*) Shows the loculated diverticulum attached to the cecum by bowel having a normal mucosal pattern simulating terminal ileum. Barium has diffused into the lumen outlining its inner wall to suggest the presence of a fecalith. (*B*) Evacuation film showing location of the diverticulum with its contained fecalith.

revealed a tense mass which, on section, revealed a fecalith. The wall was thin and semitranslucent. Microscopic examination revealed a section through the naturally appearing colon wherein the mucosa was normal. The wall was markedly thinned with the muscularis incomplete. The serosa showed marked congestion of the blood vessels.

COMMENT

Because the lesion is an unusual one, a review of the available literature was undertaken. In all, 166 cases were summarized from the original papers. Outstanding among the many excellent contributions were those of Anderson, Lauridsen and Ross, and Baker and Carlile. The cases were tabulated according to age, sex, clinical findings, preoperative and operative diagnosis, treatment and results. Diverticula were studied as to location, histopathology and presence of fecaliths. Associated pathological findings were sought.

Incidence. The true incidence of cecal diverticula is not known. It is generally regarded as rare. Jonas complains that it is scarcely mentioned in standard texts on surgery and not considered in the differential diagnosis. Neither do standard radiological texts mention it. Fifield states he found not a single case in 10,167 autopsies. Anderson reports that in 900 operations on colonic diverticulitis at the Mayo Clinic, 9 were in the cecal area. Nevertheless, we believe that the incidence is much greater than is generally supposed. Half of the cases constituting this report were found by but twenty-two authors. Lauridsen and Ross reported 6 cases within a span of two years, and the remainder of these twenty-two authors reported 3 to 5 cases each. Nearly one-half of the cases were reported in the past five years.

Fig. 2. A week later the diverticulum is still visible with the barium diffused through the fecalith.

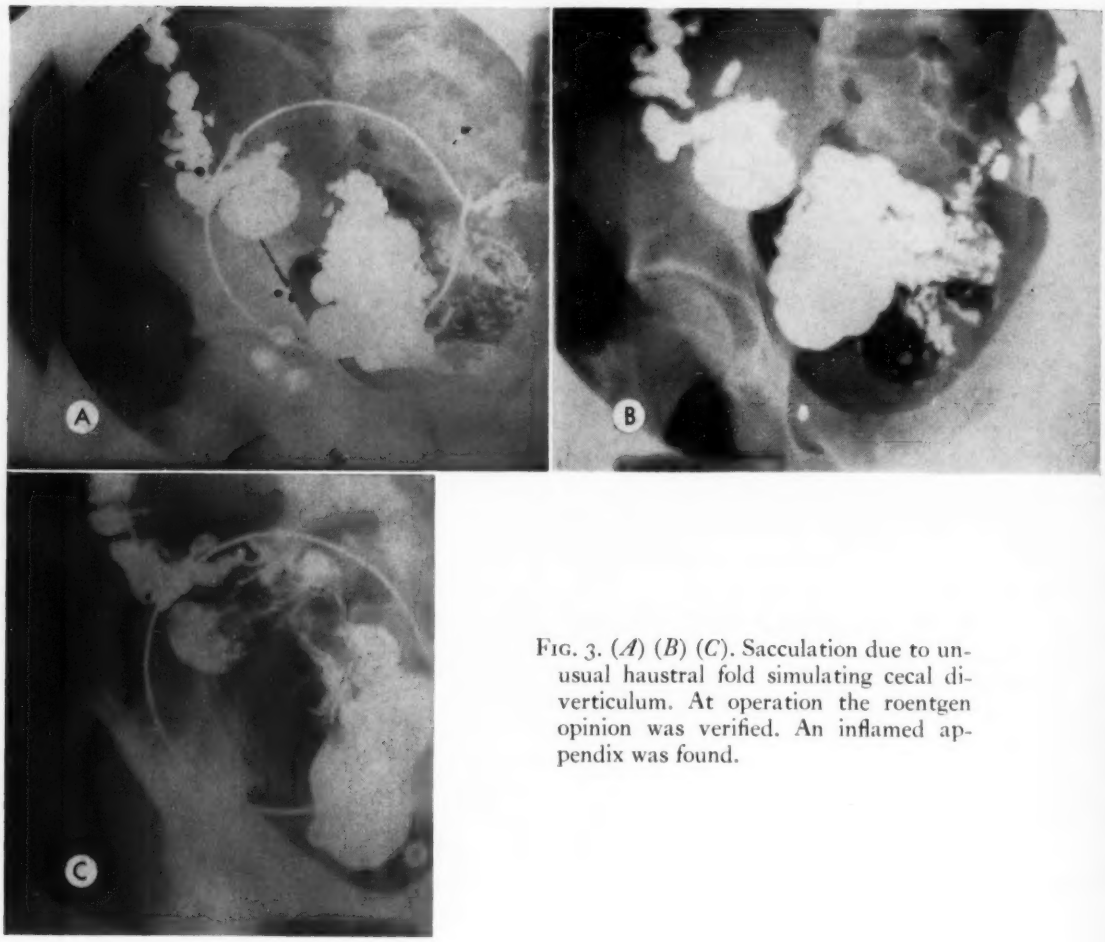

Fig. 3. (*A*) (*B*) (*C*). Sacculation due to unusual haustral fold simulating cecal diverticulum. At operation the roentgen opinion was verified. An inflamed appendix was found.

Age and Sex. Age and sex distribution of cecal diverticula is different than in the more common diverticulosis of the large intestine. In Pemberton's series of 144 cases operated upon, the sex distribution was 2:1 with males preponderating, and the average age was 53.6 years. Jonas states that only 5 per cent of the more common form of diverticulosis occurs under the age of forty. In the series constituting this report, 54 per cent were under forty with an average age for males of 38.6 and females 40.3. Odqvist and Petrén report a case in a child aged three years.

Etiology. The older authors considered cecal diverticula in the same category with generalized diverticulosis of the colon and ascribed the same theories as to cause: weakness of the intestinal wall afforded by a gap in the muscle at the entrance of blood vessels (Bennett-Jones), increased intraluminal pressure (Gant states he was able to produce diverticula by inflating the bowel with gas), adhesions due to appendiceal surgery (Greensfelder and Hiller), obesity, etc.

Cecal diverticula differ from the generalized form, however, in that they usually are single, occur in a much younger age group, and generally are of the true variety—37 out of 54 cases constituting this report. Graves reports cases in father and daughter, and Odqvist and Petrén report a case in a child aged three.

Evans believes that this diverticulum is due to irregular vacuolization of intestinal entoderm and is similar in origin to enterogenous cysts. Kelly and Hurdon (1905)

CHART I

CASES IN WHICH ROENTGEN STUDIES WERE MADE

	Study	Normal	Defect	Defect Possible Cancer	Cancer	Diverticulum	Tumor	Appendicial Stump	Opacity	Surgical Proof
Byrne, Kallan and Basset	K.U.B.								X	
Beck and Hopkins	B.E.					X				Yes
Abel	B.E.			X						
Reid	B.E.					X				Yes
Nocito and Cottini	B.E.						X			
Sumii	B.E.		X							
Rogers and Hilton	B.E.	X								
Porter	B.E.				X					
Thomsen	B.E.	X								
Jonas	B.E.	X								
Greensfelder and Hiller	B.E.							X		
Anderson, Case 5	B.E.		X							
Anderson, Case 7	B.E.		X							
Weible	B.E.					X				Yes
Migliaccio*	B.E.					X				No
Burgess	B.E.					X				

* Diagnosed his case by surgical exploration and proved by barium enema subsequently.

studied the origin in over 50 human embryos from the Mall-Brodel collection and saw an outgrowth from the tip of the cecum which enlarges during the sixth week of fetal life and atrophies the seventh. Gladstone and Wakely confirmed this observation in 1924. Though the etiology is not definitely known, the age and sex distribution, embryological studies, presence of the lesion in a child aged three, its finding in father and daughter, and histopathological findings, would seem to place it as a different lesion from the more common form of diverticulosis and most likely on a congentital basis.

Diagnosis. Preoperative and operative diagnoses are summarized in Table 1. In the usual case of cecal diverticulitis, the patient complained of generalized abdominal pain which eventually localized in the right lower quadrant. Or, right lower quadrant pain, nausea and occasional vomiting were present from the start. Other symptoms were infrequent and included anorexia, diarrhea and dyspepsia. On physical examination there was low grade fever, tenderness over McBurney's point and guarding. A mass was felt in 50 of 148 cases. Since the surgeon generally felt he was dealing with a case of appendicitis, in 77 per cent of those reporting a preoperative diagnosis, little laboratory work was done with the exception of a blood count, which generally was elevated.

Roentgen Examination. Roentgenograms were generally not taken. Only 16 cases were subjected to this procedure, 1 kidney, ureter and bladder, and 15 barium enemas. Distribution of findings is noted in Chart 1. A diagnosis of diverticulum by barium enema and surgically proved was made 4 times, our case constituting the fourth. One case was diagnosed by surgical exploration and proved by barium enema postoperatively (Migliaccio).

In the main, surgeons felt that a barium enema was contraindicated in the presence of an acute abdomen, that the diverticulum would not show up in the presence of a fecalith or that other roentgenological procedures would not be of value. There could, however, be no objection to a flat film of the abdomen which might demonstrate a fecalith shown to be present in one-third of the cases, and in some instances a cautious barium enema might not be contraindicated. As to nonfilling of a diverticulum in the presence of a fecalith, Golden states that many diverticula containing fecaliths will show up as a ring surrounding the fecal mass This was true in our case (Fig. 1).

Clinically, the preoperative diagnosis

TABLE I

DIAGNOSIS—PREOPERATIVE AND OPERATIVE

		Preoperative	Per Cent		Operative	Per Cent
Appendicitis		109	77		0	0
Malignancy		6	4.2		48	30.8
Diverticulum		4	2.8		97	62.0
All others		23	16.0		11	7.0
Bullet wound	1			0		
Abscess	12			2		
Pelvic inflammatory	4			4		
Meckel's diverticulum	2			1		
Strangulated inguinal hernia	1			0		
Tuberculosis	0			2		
Benign ulcer	0			1		
Perforated cecum	0			1		
Cholecystitis	3			0		
Total reporting		142			156	
Unknown		24			10	
Total		166			166	

was made but once by Shiota in Sumii's case and was based on a finding of a right lower quadrant mass which disappeared in a few days A barium enema was reported as a cecal defect. Beck and Hopkins found 3 fecaliths in their series of 5 cases and suggested that this might serve as the basis for a diagnostic triad:

1. Fecalith.
2. Recurrent symptoms of right lower quadrant inflammatory disease.
3. Previous appendectomy.

Since previous appendectomy was reported in only 12 cases, and a palpable mass in one-third of the cases, the latter finding might better serve as the third member of the triad.

Operative Diagnosis. The operative diag-

TABLE II

TREATMENT AND RESULTS

		Cases	Reported	Deaths	Per Cent	Complications	Per Cent
Excision		69	62	0	0	9	12.8
Inversion		9	8	0	0	0	0
Colon resections		63	56	4	11.4	10	17.4
Hemicolectomy	38						
Cecectomy	18						
Ileocecal resection	7						
Others		19	19		15.8		26.0
Appendectomy	7			0		2	
Exteriorization	3			0		2	
Drainage	4			2		1	
Exploration	1			0		0	
Observation	1			0		0	
Perforation sutured	3			1		0	
		160	145	7		24	

Table III

GROUP MORTALITY

Correctly Diagnosed	Incorrectly Diagnosed	Group as a Whole	Enlarged Operative Group
2/96	5/59	7/155	4/56
2.1%	8.5%	4.5%	11.4%

nosis was not always clear. Jonas points out that the disease process was often so intimately connected with the cecum, so tumefied, and so frequently associated with regional adenopathy, it was not unusual for the surgeon to mistake the lesion for a malignancy. He advised that palpation at the base of the diverticulum through the opposing cecal wall would often reveal the opening to the diverticulum and the fecalith. In this series the operative diagnosis was made only 97 times in 156 reportings, or 62 per cent of the cases. Others, too, were impressed with difficulties in the operative differential diagnosis, and Busch and Friedfeld, and Baker and Carlile stressed its importance. The latters' operative differential is as follows:

1. Carcinoma is either cauliflower, infiltrative along the cecal wall, or perforative, with the latter two most apt to metastasize to the regional nodes and most apt to be confused with cecal diverticulitis.
2. Tuberculosis is manifested by small tubercles on the serosa, terminal ileum involvement, adhesions, and large caseous glands.
3. Actinomycosis is manifested by cecal induration, and in the latter stages by sinus formation discharging characteristic sulphur granules.
4. Nonspecific granuloma involves the ileum, serosa is granular, bowel wall thickened, mesentary edematous, and glands inflammatory in nature.
5. Nonspecific ulcer has the same complications as peptic ulcer—perforation, hemorrhage and obstruction.
6. Simple inflammatory tumors of the cecum.

TREATMENT AND RESULTS

Operative procedure, mortality rates and complications are summarized in Table II. The most common procedure was excision. There were no deaths in this group and a complication rate of 12.8 per cent. Henry states that this is the operation of choice since the edges are usually normal and closure possible by purse-string sutures even when the diverticulum is gangrenous. An alternative procedure which proved equally satisfactory was inversion. More extensive surgery on the cecum was carried out when that viscus was edematous (Frehling), or when the lesion was too close to the ileocecal valve so that there was danger of impairing cecal blood supply (Lauridsen and Ross, Jonas).

Some type of colon resection was done in 63 cases of which 56 reported results, with a mortality of 4, or 11.4 per cent. In 48 of the cases, hemicolectomy was felt to be necessary either because of an outright diagnosis of carcinoma or a high index of suspicion as to its presence. In the remaining 15 cases, hemicolectomy was felt to be necessary either because the extensive inflammatory process made the lesser operative procedure inadequate or because nearness of the diverticulum to the cecal blood supply made excision hazardous.

Under "others" are listed 7 appendectomies. One of the surgeons placed sulfa in the wound, two others did additional drainage. The remaining four felt, as did Burgess, that the course of diverticulitis is to subside without perforation or other complications, and left an inflamed diverticulum in situ while removing a normal appendix. Nevertheless, there were 18 perforations, 12 gangrenous diverticula, 3 suppurative diverticula and 2 abscesses reported.

Factors Affecting Results. Factors affecting results were incorrect operative diagnosis and unnecessarily severe operations.

As will be seen from Table III, mortality in the correctly diagnosed cases was 2.1 per cent as compared to 8.5 per cent in the incorrectly diagnosed group and 11.4 per cent in those subjected to the enlarged operative procedure.

PATHOLOGY

Pathologically the lesion was classed as a true diverticulum in 37 out of 54 cases reporting histopathological findings. The majority of them were located within 1.5 cm. from the ileocecal valve, anteriorly, laterally, or medially. The overwhelming majority of them were inflamed, 35 going on to suppuration, gangrene and perforation. A fecalith was found in one-third of the cases. Associated findings were acute appendicitis 11 times, peritonitis 7 times, abscess formation 5. A Meckel's diverticulum and torsion of the omentum were found once.

SUMMARY

A case of cecal diverticulum diagnosed by roentgen ray and proved surgically has been presented and the original literature reviewed. An attempt has been made to analyze the findings to show that this lesion is more common than suspected; that it is a different lesion than the more common colonic diverticulosis; that the preoperative diagnosis is usually confused with an acute appendicitis but that it can be made if a high index of suspicion is entertained, especially in the presence of previous appendectomy with recurrence of symptoms of right lower quadrant inflammatory disease and the presence of a sharply circumscribed mass; that a minimum roentgenologic investigation consisting of a film of the kidney, ureter and bladder is indicated in view of the fact that in one-third of the cases a fecalith is found; that the mortality and morbidity rates are dependent on the preoperative and operative diagnosis; and that the operation of choice is excision with inversion as a satisfactory alternative and the enlarged resections reserved for those cases where the diverticulum is too near the ileocecal valve or placed between the leaves of the mesentery so as to endanger the cecal blood supply.

CONCLUSIONS

1. Cecal diverticulum is a more common lesion than is generally supposed.
2. The preoperative diagnosis is possible if a high index of suspicion is entertained and minimum roentgen examination is made.
3. The operative diagnosis is often not clear because of similarity to malignant disease.
4. The usual lesion is placed close to the ileocecal valve and is of the congenital variety.
5. Local excision is the operation of choice.
6. With increased recognition of the entity in standard textbooks and at operation, mortality will decrease.

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We wish to express our gratitude to Mrs. Freda L. Wood, Chief Librarian, at Veterans Administration Hospital, Fort Wayne, Indiana, for her help in compiling the literature.

ADDENDUM

Since this report and scarcely six months after discovery of our first case, we found a second one. Patient was a thirty-two year old colored male admitted to the Surgical Service on March 13, 1953, as an emergency acute abdomen. His chief complaint was generalized abdominal pain of twenty-four hours' duration which localized in the right lower quadrant.

On physical examination there was marked direct and rebound tenderness in the right lower quadrant with pain in the same area on rectal examination. Temperature was 101°F., pulse 88 and respirations 20. A diagnosis of acute appendicitis was made, and at operation the appendix was normal. On exploration of the cecum, two diverticula measuring 1.5 by 0.8 cm., both acutely inflamed, were found. These were excised. Recovery was uneventful.

Again we wish to stress that awareness of the existence of the lesion is important in finding it, and that on finding a normal appendix at operation, the cecum as well as the gallbladder,

terminal ileum and pelvic viscera should be explored.

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SURGICAL MANAGEMENT OF INTRAORAL CANCER*

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CURE rates of cancer of the mouth are universally disappointing, particularly when compared to the salvage in histopathologically comparable tumors of the skin, lip, and uterine cervix. The latter comparison is especially pertinent because this location is even less accessible than oral cancer, yet in the cervix radiotherapy has produced better end results. Historically, irradiation superseded surgical treatment of squamous cell carcinoma, in its various sites of origin, soon after the differential effects of radiant energy on tissues were demonstrated. Radiotherapy of oral cancer has run the gamut from low voltage unfiltered roentgen rays through all the various methods of application of radium, and the unimproved results of supervoltage therapy, to the point where an impasse has been reached. In the meantime the surgical potential in the cure of oral cancer has been enhanced to a degree that deserves review by all serious antagonists of the disease. Quondam protagonists of any one modality should be prejudiced in only one direction, against cancer.

The surgical treatment of mouth cancer, like radiotherapy, has gone through several evolutionary phases. Transoral local excision, often combined with cautery, was of course the primary approach, but sepsis and slough resulted in prolonged and painful healing, and the cure rates were poor except in the small and superficial lesions of the tongue. The occasional radiation cure of more extensive, and even technically inoperable lesions, quickly made irradiation the general treatment of choice. As studies progressed, it became apparent that cervical metastatic disease was a major factor in irradiation failure, and surgery again was utilized. Through the pioneer work of Butlin in England and others in France and America, the operation of "block dissection" of the neck was developed. The salvage in metastatic neck cancer by this procedure, although still quite unsatisfactory, was demonstrably superior to the salvage from irradiation, this latter modality achieving only an occasional control in the fortuitous circumstances where the disease was exceedingly radiosensitive, or where metastasis was solitary.

As irradiation methods improved, and tumor doses increased, more patients survived longer. Radionecrosis became a factor in the cured cases, necessitating many late operations for removal of necrotic and infected bone. Sequestrectomy of the mandible became a recognized by-product of radiation cure in a definite percentage of patients. At the same time it became clear that carcinoma invading bone was virtually incurable by irradiation techniques.

These considerations furnished a rationale for the surgical concepts of neck dissection and removal of jaw and soft parts in continuity, which had been proposed years before, but which had never been put to any extensive trial because of the prohibitive mortality, and because radiation techniques came into the picture and seemed so promising.

In the last ten years developments in the ancillary sciences have completely changed the surgical picture to the point where extensive excisional surgery in contaminated fields may be safely accomplished. At the same time new techniques of irradiation have recently been developed, with more promising results, so that it seems only fair to explore both modalities.

ADVANCES IN SURGICAL FACILITIES

Increasing ability to control or modify both normal and pathological biologic

* From the Department of Surgery, University of Illinois, College of Medicine, Chicago, Illinois. Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

Fig. 1. Postoperative photograph at eleven days after a combined neck dissection, hemiglossectomy, and removal of the hemimandible.

mechanisms has made possible the safe application of extended excisional surgery. The perfection of intratracheal anesthesia has contributed immeasurably to the safety and ease of prolonged operative procedures about the head and neck area. Modern anesthesiology has made it possible to seal the airway completely from the operative field and carry a patient in a light plane of anesthesia for four or five hours with the patient awake and reacting, with normal cough reflexes, at the end of the operation.

The antibiotics have played a major role in potentiating these operative procedures, by practically eliminating wound infection and sepsis. The combined operations now being done necessarily produce contaminated fields, and before the advent of antibiotic control of infection, the mortality of these procedures was prohibitive.

A third important adjunct development has been the gradual improvement of our understanding of repair of the nutritionally depleted patient. Many patients with oral cancer, particularly those with recurrence after radiotherapy, are in such a serious state of metabolic deficiency that they are very poor or impossible surgical risks. It is now possible to restore such individuals in a few days, by parenteral and tube feeding methods, so that a temporarily and artificially well patient is available for surgery.

The development of blood banks and our increased knowledge of the prevention and treatment of shock have contributed a further impetus to the surgical attack on oral cancer. Knowledge of fluid and electrolyte balance has enabled doctors to maintain patients in metabolic balance through critical periods, sometimes of many weeks' duration.

Two other areas of accumulated data have afforded a rationale for further exploration of the possibilities of surgical therapy of oral cancer.

a. *Natural History of Squamous Cell, or Epidermoid, Carcinoma.* It is now recognized that many, if not most, forms of carcinoma metastasize quite readily by the venous route as well as by lymphatics. This, of course, explains the distant dissemination of carcinoma of the breast and kidney to the spine, pelvis, lung, brain, and skull. Venous invasion is the obvious source of liver metastases from carcinoma of the gastrointestinal tract. Squamous cell carcinoma, in contrast, has a minimal tendency in this direction, this tumor metastasizing mainly by way of the lymphatics. Clinically this is reflected by the fact that most patients dying with epidermoid carcinoma of the head and neck, admittedly advanced cancer, at autopsy show no spread of disease below the clavicles. In other words, in

Fig. 2. Postoperative photograph of an eighty-two year old man who had an extensive lesion of the left mucosa, involving the commissure of the mouth, ulcerating through the cheek, with multiple cervical lymph node metastases and deep excavation of the mandible. Irradiation here would have left a huge defect in the cheek, which would have been difficult to repair in the irradiated edge. This man survived four years free of disease and died of cardiac failure without evidence of recurrence of the tumor.

the majority of cases we are dealing with a regionally localized disease and are not confronted, to any great extent, with the problem of distant dissemination. These cancers kill by the effects of local destruction. Oral cancers kill by interference with nutrition, airway obstruction, erosion of major vessels, and pain. These considerations afford a greater cure potential if surgical measures can be devised which will remove the primary lesion, regional lymph node metastases, and the intervening lymphatics in an "in continuity" dissection.

Another aspect of the natural history of oral squamous cell carcinoma that is little appreciated is the fact that most of these tumors arise through a process of "field cancerization." These neoplasms are of multicentric origin, arising in an area of pre-conditioned epithelium which has been irreversibly conditioned to maturation into cancer.[5] Wood and Boag[2] have stated that a third of their radiation failures is due to persistence of precancerous lesions, these areas being less radiosensitive than the treated carcinoma.

b. *Surgical Rationale Based on Differential Radiosensitivity of Tumors, Both as to Histopathology and Location.* There is considerable variation in the radiosensitivity of different forms of epidermoid carcinoma, ranging from the relatively resistant, well differentiated squamous tumors to the relatively sensitive "lympho-epitheliomas" or Grade 3 or 4 "transitional cell" carcinomas of Waldeyer's ring. Carcinomas other than squamous cell occur in the oral cavity and these are practically all radioresistant, requiring surgical treatment. These are the minor salivary gland tumors and others that will be detailed below.

As to the location, it is generally agreed that cancer invading bone is not radiocurable, although this is somewhat less true of cancer only eroding bone.

Tumors recurring or persisting after optimum radiotherapy are generally considered to be radioresistant. Whether or not this apparently obvious conclusion is valid, the fact remains that the tissue radiation tolerance in such a clinical situation has been largely exhausted, and further irradiation with a cancerocidal dose is impossible, the only recourse being surgery.

INDICATIONS FOR SURGICAL THERAPY OF ORAL CANCER

I. *Obligate Indications*

A. *Tumors recurring or persisting after irradiation.* Assuming technical resectabil-

ity, this category would seem to be manifest, if any further curative responsibility is seriously considered. A generally ignored fact is the frequency with which this clinical setting of postirradiation recurrence presents itself. To the casual or wishful thinking observer, the occasion demanding "radical" or "mutilating" surgery would appear to be infrequent, but when one considers that the over-all *reported* cure rate in unselected cases of oral cancer treated by radiation is around 30 per cent, the 70 per cent implied failure rate indicates that the majority of oral cancer patients may be candidates for surgery in this category at some time in their clinical course. The author is pessimist enough to believe that the *unreported* radiation cure rate is far less than that documented.

B. *Bone invasion.* Actual invasion of the maxillae by oral cancer is rarely cured by irradiation. If a sterilizing tumor dose is delivered, the bone will undergo radionecrosis, requiring surgical removal. The subsequent tissue repair and healing processes will be impeded by infection and poor blood supply in partially devitalized tissues. This predictable situation should be treated surgically in the first place. If bone will be eventually lost due to radionecrosis, bone graft or plastic reconstruction is incomparably easier in nonirradiated tissue.

C. *Tumors of minor salivary glands.* The mucous glands underlying the mucosa of the oral cavity can reproduce the same histopathologic tumor types as the major salivary glands such as the parotid. These neoplasms are notoriously radioresistant and are rarely radiocurable. The tumors comprising this group are the occasional benign mixed tumors, the borderline or frankly malignant mixed tumors, the adenoid cystic carcinomas or cylindromas, and the mucoepidermoid carcinomas. Except for the rare benign mixed tumor, the curability of the others is low by any method, but in my experience adequate excision is preferable to radical irradiation, both as to elimination of the disease and as to restoration of function if eliminated.

D. *Adamantinomas or ameloblastoma.* These tumors are malignant epithelial tumors of bone and their treatment is entirely by surgical extirpation. They are slow-growing and may last for many years, but if cure is attempted, temporizing inadequate surgery, or radiotherapy, is futile.

E. *Sarcomas and neurogenic tumors.* Sarcomas in the oral cavity are rare but they do occur, particularly osteogenic sarcoma of the maxillae. These are entirely surgical problems and should never be irradiated in a curative attempt. The only sarcoma in the oral cavity that is radiosensitive is the lymphosarcoma and this, of course, is not a surgical problem.

Neurogenic tumors occur rarely about the mouth and, again, are surgical problems. They usually are tumors of peripheral cranial nerves projecting into the oral cavity. Occasionally, however, neurosarcomas of the lip or oral cavity do occur. They are entirely surgical problems.

F. *Radiation cancer.* Radiation cancer is perhaps one of the rarest forms of carcinoma occurring in the oral cavity but the author has personally had 7 cases of this condition and these are, of course, entirely surgical problems. The tissues are damaged by previous irradiation to an extent that further radiotherapy is not feasible.

G. *Cervical lymph node metastases.* The treatment of the primary lesion in the oral cavity is only half of the treatment of oral cancer. These cancers all can metastasize to the cervical lymphatics and frequently do. This metastatic potential apparently cannot be eliminated by so-called "prophylactic" irradiation to the lymph node bearing areas about the neck and this should never be utilized as a form of treatment. It is my practice not to do prophylactic neck dissections but only regional lymph node dissections when there is clinical evidence of metastatic disease. Cervical lymph node metastasis is only very rarely solitary, as usually multiple lymph nodes and multiple lymph node groups are involved, although only one focus may be apparent clinically. Therefore, whenever cervical metastatic disease is apparent clinically, and technically operable, a complete neck dissection

should be done. Bilateral radical neck dissection with removal of both jugular veins can be done safely in one stage and bilateral cervical metastasis is no contraindication to surgical treatment of the disease, if the primary lesion is sterilized or can be removed at the same time with an "in continuity" procedure.

II. *Preferable Indications*

A. *Superficial exophytic lesions.* Superficial exophytic lesions, particularly about the tip of the tongue, would seem to be best handled by simple excision. This also applies to lesions in leukoplakia where the entire area must be excised because of the difference in the radiosensitivity between leukoplakia and carcinoma. The leukoplakia will constitute a precancerous lesion and the chance of further development of carcinoma is so great that these lesions, when feasible, should always be excised.

B. *Youth.* Youth would seem to be a relative contraindication to the use of radiation. The effects of radiation on tissue the both permanent and progressive and are older a person is, the less life expectancy he has normally for late effects of radiation. This applies in general to radiation therapy but I think, in particular, about the face and mouth where exposure to sun over a long period of further life can be quite damaging to areas where external irradiation fields have been used.

C. *Isolated keratinizing squamous cell lesions of the base of the tongue with pharyngeal wall involvement.* These are best handled surgically in my experience. They are not particularly radiosensitive and the patients seem to do better with a cleanly healed surgical wound while the cure rates would appear to be at least comparable, if not superior. Furthermore, many of these lesions manifest themselves initially with cervical lymph node metastases, so that they are usually removed by neck dissection and "in continuity" pharyngotomy.

III. *Optional Indications*

Small and superficial oral cancers, particularly those of the lateral border of the tongue, would seem to be easily treated surgically with much less discomfort and annoyance to the patient. Thus, in many cases it would appear that a superficial partial glossectomy is superior to radiation treatment, although the cure rates may be exactly equal. To have a cleanly healed wound in five or six days as compared with five or six weeks of radiation reaction, plus the simplicity of such a surgical procedure, would seem preferable, from the patient's standpoint at least.

TYPES OF SURGICAL PROCEDURE USED IN THE TREATMENT OF ORAL CANCER

Aside from the usual trans-oral procedures of local excision, and even hemiglossectomy, in the last ten years or so the combined procedures have become more and more frequently used. These procedures comprise a regional lymph node dissection, either unilateral or bilateral, plus removal of the primary lesion and the intervening lymphatics, in an "in continuity" dissection. The jaw, either as a hemimandible or as a partial jaw resection, is frequently included in this type of procedure. This technique has been described on several occasions.[2,3,6] In the original derivation of these techniques they were applied only to advanced cancer, recurrent after radiotherapy, and usually with invasion of the mandible. When it was demonstrated that some of these patients could be cured by this procedure, in these advanced stages, the operative procedure was applied to earlier cases in the hope that the cure rate would be improved. In many of the original operations, the mandible was taken because it constituted an architectural bar to access to the mouth or to repair following surgery. Recently new operative techniques have been devised to preserve the mandible. Kremen[1] has described a procedure whereby he sections the mandible at the symphysis, followed by dissection of the neck and soft parts, and then rewires the mandible. Slaughter and Southwick[4] have devised a so-called "exteriorization operation," whereby the mandibular arch is preserved intact when the jaw is not directly involved

by tumor. In addition to these procedures, temporary immediate bone grafting has been performed. Modifications, such as a situation when only a portion of the mandible has been removed, have been devised, whereby Kirschner wires may be placed between the fragments to maintain the normal mandibular arch. Plastic devices also have been employed on occasion. These techniques are still in the developmental phase and the final optimum procedure has not been devised as yet. In our own series of 120 combined procedures we have a five year survival rate of 32 per cent free of disease. This figure does not look promising but, on the other hand, one must remember that these operations initially were applied only to far advanced cases and many of them constitute recurrence after radiation therapy, which is an impossible situation from the standpoint of cure by radiotherapy, particularly when cervical lymph node metastases are present.

DISCUSSION

It would appear that radiotherapy and surgery each have a distinct place in the management of oral cancer. This consideration is only for the most experienced radiotherapists and cancer surgeons. The big problem is that there are not enough radiotherapists, and it is my impression that a capable cancer surgeon can accomplish more than an inexperienced radiotherapist. The opposite is, of course, equally true. It has become apparent that the combined surgical procedures will salvage a reasonable percentage of patients who can be considered as failures of radiation cure. These people have impossible problems from the standpoint of further irradiation and, up to the time these procedures were devised, all succumbed to their disease. It would seem that, if these advanced lesions can be cured surgically, these procedures should be tried in earlier cases with a hope of increasing the over-all salvage rate of the moderately advanced and advanced non-irradiated cases.*

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* For discussion see page 635.

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RADIOTHERAPY OF CANCER OF THE TONGUE AND FLOOR OF THE MOUTH*

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IN THE discussion of the treatment of any disease for which there is no specific, there is bound to be considerable controversy as to the merits and disadvantages of the various treatment methods advocated. Such is the case is oral cancer, where much is left to be desired in the results obtained either by radiotherapy or surgery. It is important, therefore, to take stock occasionally in order to assess exactly what has been accomplished and in which direction improvement may be sought.

The material on which this presentation is based represents a study of patients seen in the Ontario Institute of Radiotherapy and the Department of Radiotherapy in the Toronto General Hospital during the period from 1929 to 1949. For almost this entire interval the Clinic was under the directorship of the late Dr. Gordon Richards, a member of this Society, who died in January, 1949.

Many years ago it was realized that unless there was close cooperation between the various departments of the hospital interested in the treatment of malignant disease, there was a very real danger of the development of opposing schools of thought. It was recognized, moreover, that with a combination of effort, the true role that each form of treatment would play in the management of malignant disease could be determined, and in this manner the best interests of the patient obtained. The Oral Clinic was no exception. In attendance are present not only a radiotherapist, but a consulting surgeon and a representative from the Department of Dentistry. Patients are seen on their initial visit and throughout their entire follow-up by this group. In this manner a treatment policy has gradually evolved. The five year studies are based on 394 cases of cancer of the tongue and 95 cases of cancer of the floor of the mouth. Tables I and II indicate the distribution by age and sex, as well as the incidence of lymph node metastases in this series.

TABLE I

CARCINOMA TONGUE

1929–1949—Three Year—441 Cases

Average Age		63.2 years
Sex Incidence:		
Male		75.3%
Female		24.7%
1929–1947—Five Year—394 Cases		
Involvement of Lymph Nodes:		
On Admission	131	33.2%
Later Development	86	21.8%
Total	217	55.0%

GENERAL OBSERVATIONS AS TO TREATMENT POLICY

In general, it is felt that primary lesions of the oral cavity, including the lip, are best treated by radiotherapy, while the secondaries developing in the lymph nodes of the neck are most adequately treated by radical surgery. There are, of course, some exceptions to this policy, but in general it is true. Surgery to the primary lesion may sometimes be preferred to further irradiation if initial radiotherapy has failed, when it is still possible to excise a small residuum, or in the instance where a chronic ulcer may have developed. On occasion, inoperable masses in the neck have become operable following irradiation, and

* Presented in a Symposium on Treatment of Cancer of the Oral Cavity at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

TABLE II

CARCINOMA OF FLOOR OF MOUTH

1929–1949—Three Year—110 Cases

Average Age		66.5 years
Sex Incidence:		
Male	102	92.7%
Female	8	7.3%

1929–1947—Five Year—95 Cases

Involvement of Lymph Nodes:		
On Admission	21	21.1%
Later Development	22	23.2%
Total	43	44.3%

have proved possible of removal. If metastases in the lymph nodes are inoperable from either the point of view of extent of disease or poor general condition of the patient, an attempt at palliation is usually made either in the form of external irradiation or radium needle or radon seed implant.

METHODS OF TREATMENT

The cases here reported represent more or less examples of all the various forms of radiotherapy that have been suggested at one time or another; namely, radium in the form of molds, needles, radon seeds, teleradium therapy; or roentgen rays of 200 to 400 kv. as well as intraoral roentgen rays generated at 88 to 200 kv. Not infrequently diathermy may be combined with the above treatment. The opinion is held that in the more bulky lesions, or in those that are ulcerated with overhanging indurated margins, more satisfactory results are obtained: both from the point of view of healing and eradication of disease, and with a great deal less slough into the oral cavity, if this exuberant tissue is removed by diathermy either prior to, or at the time of treatment. It has long been recognized that the more bulky the lesion, the greater the likelihood of residual disease remaining after treatment. If it is possible to reduce this bulk without interfering with the blood supply of the tumor bed, and without risk of spread of disease, it is felt that the radiotherapeutic measures adopted will be more likely to meet with success in the sterilization of the area from cancer cells. This, we feel can be accomplished by the use of electrocoagulation.

In general, radium, usually in the form of needles, but occasionally in the form of gold radon seeds, is employed for the treatment of localized lesions of the tongue and floor of the mouth. It is considered that in the more advanced lesions, it is difficult to obtain an even dosage and that the risk of not covering the entire area of involvement is too great for the employment of radium needles alone. Initially, these lesions are best treated by external irradiation, supplemented if possible by an intraoral cone. Subsequently, small residual masses are usually treated by interstitial radium implant, occasionally supplemented by electrocoagulation.

The aim in the treatment of cancer of the tongue and floor of the mouth, as it is elsewhere by radiotherapy, is to deliver a lethal dose to the entire tumor-bearing area with minimal damage to adjacent normal structures, so that healing may occur with as good a functional result as possible. As the therapeutic ratio is not great, the doses delivered have to be judged quite accurately in order to achieve this. It is important, therefore, in planning treatment to think in terms of the tumor dose that is to be delivered, and not in terms of air, or skin dose, or milligram hours. In addition, the expression of the dosage given in terms of tumor dose allows for comparison of treatment methods and results from various centers more accurately. The services of a physicist are, of course, highly desirable in the planning of treatment and in aiding in the calculation of the dosages obtained, particularly if large numbers of patients are being treated. If such services are not available, then the radiotherapist must be prepared to do this himself. There are several dosage systems in use which act as a guide in the planning of treatment. I refer to those of Quimby, Paterson and Parker and Strandqvist. These form a

FIG. 1. Treatment by multiple portals; cancer of the right side of the tongue. (*A*) Portal No. 1. Right superior oblique. (*B*) Portal No. 2. Right anterior inferior oblique. (*C*) Portal No. 3. Right posterior inferior oblique. (*D*) Portal No. 4. Left submaxillary.

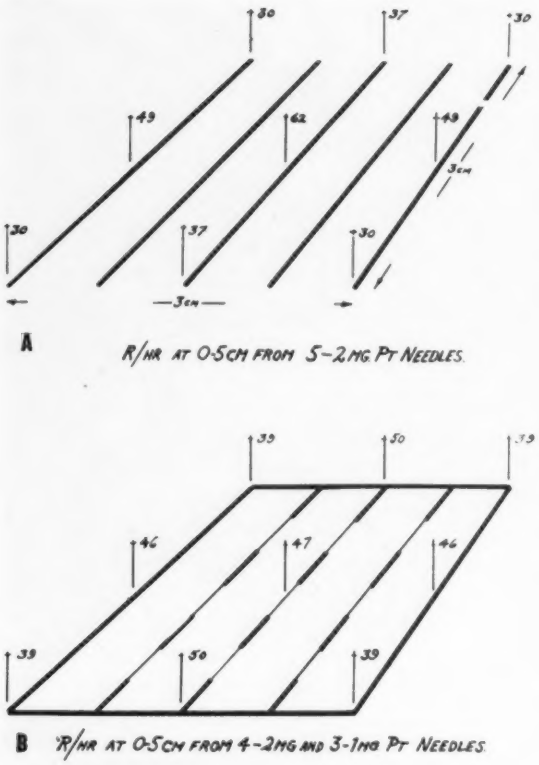

Fig. 2. (*A*) Variation in dosage from 30 to 62 r per hour. (*B*) Variation in dosage from 39 to 50 r per hour.

sound basis and guide of dosages, but not infrequently they may have to be modified in individual cases.

High Voltage Roentgen Therapy. The high voltage roentgen therapy in this series prior to 1937 was carried out at 200 kv.,

Table III

Carcinoma of Tongue

1929–1947

Five Year Survival Rates by Stage of Disease

Stage	Number	Gross Survival	Net Survival
I	61	54.1%	64.7%
II	136	37.4%	47.7%
III	136	15.0%	17.6%
IV	61	2.3%	3.3%
Total	394	27.2%	31.7%

Net survival excludes untraced cases—4, and those dying of extraneous disease—52.

Table IV

Carcinoma of Floor of Mouth

1929–1947

Five Year Survival Rates by Stage of Disease

Stage	Number	Gross Survival	Net Survival
I	20	65.0%	68.4%
II	31	48.4%	55.5%
III	30	23.3%	26.9%
IV	14	14.3%	14.3%
Total	95	38.9%	43.2%

Net survival excludes untraced cases—1, and those dying of extraneous disease—8.

and subsequently by roentgen rays generated at 400 kv., with a half-value layer varying from 4 to 4.5 mm. of copper, with an output of 7 to 12 r per minute at 100 cm. distance. The multiple portal technique has been used, as shown in the accompanying illustration (Fig. 1), with the beams

Table V

Stage of Disease

The Primary Lesion:	
Stage I	A unilateral or single lesion measuring not more than 1.5 cm. in diameter
Stage II	A lesion not larger than 3 cm. in diameter with a corresponding degree of ulceration or infiltration
Stage III	A lesion involving not more than half of the entire tongue or involving other adjacent structures
Stage IV	A lesion characterized by massive involvement of more than half of the tongue
Secondary Involvement:	
Stage I	Unilateral, small, discrete, movable, operable
Stage II	Larger, up to the size of 1 cm., still discrete, unilateral; or lymph nodes as described in ⟨1⟩ but which are bilateral. Operable
Stage III	Massive metastatic carcinoma in lymph nodes, matted and immovable. May be unilateral or bilateral. Inoperable

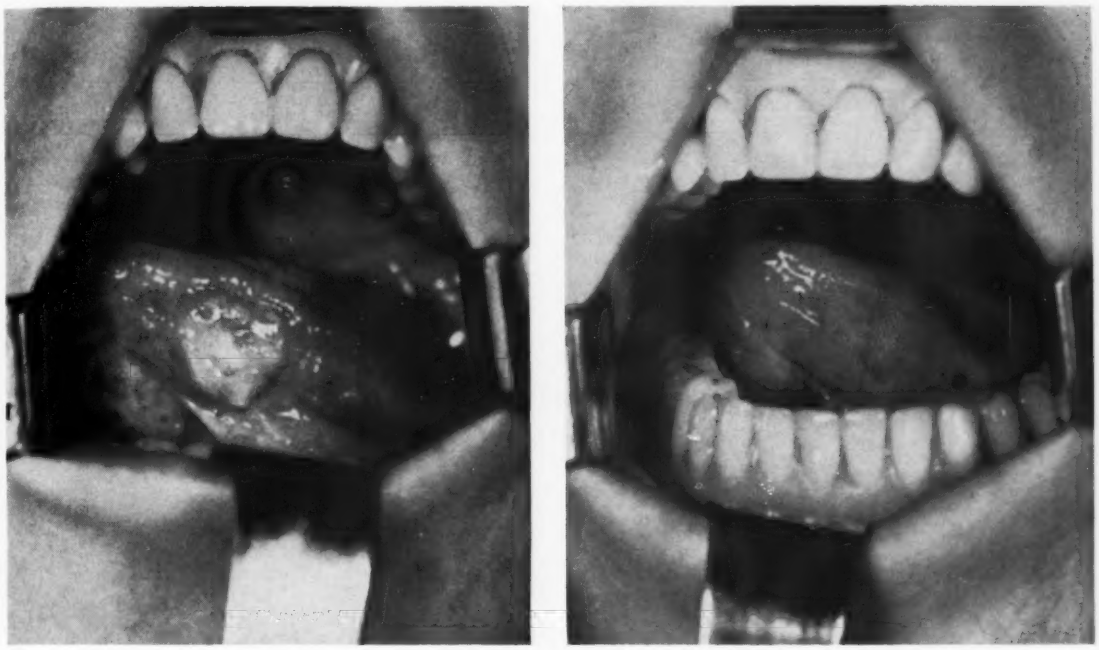

Fig. 3. Cancer of the tongue. Interstitial radium implant. Four years, no recurrence.

converging on the tumor-bearing area. This technique has the advantage that it includes the immediate lymphatic drainage areas in the treatment field. While it is recognized that metastatic nodes are not readily cured by radiotherapy, nevertheless it is felt that they are influenced to some extent, and may become relatively

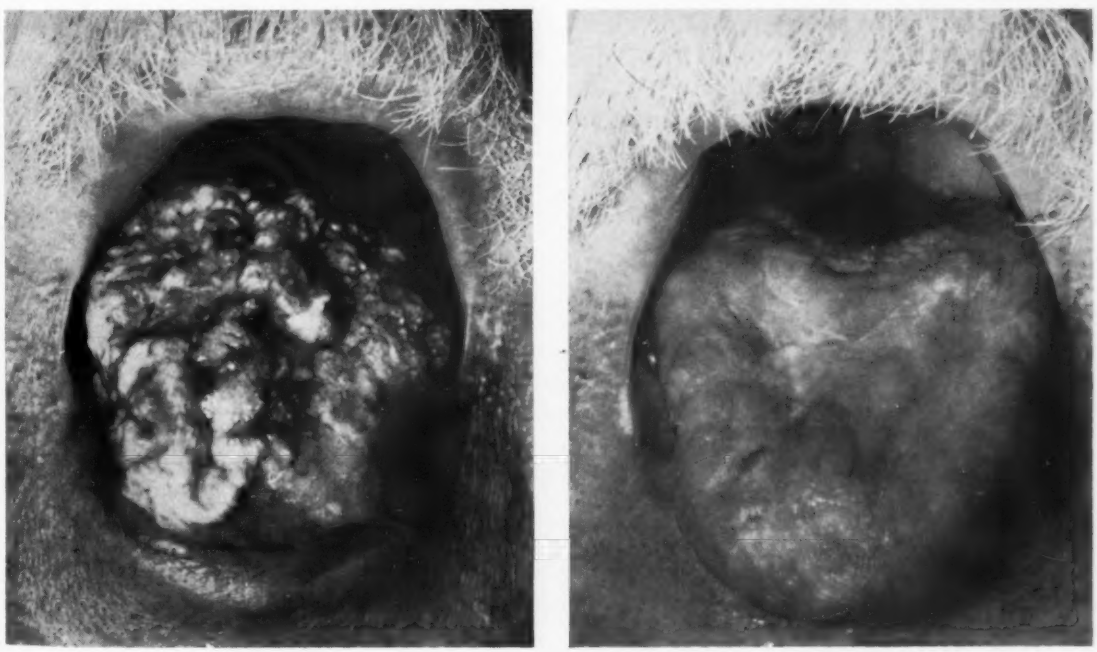

Fig. 4. Cancer of the tongue. External roentgen irradiation plus intraoral roentgen irradiation. Fourteen years, no recurrence.

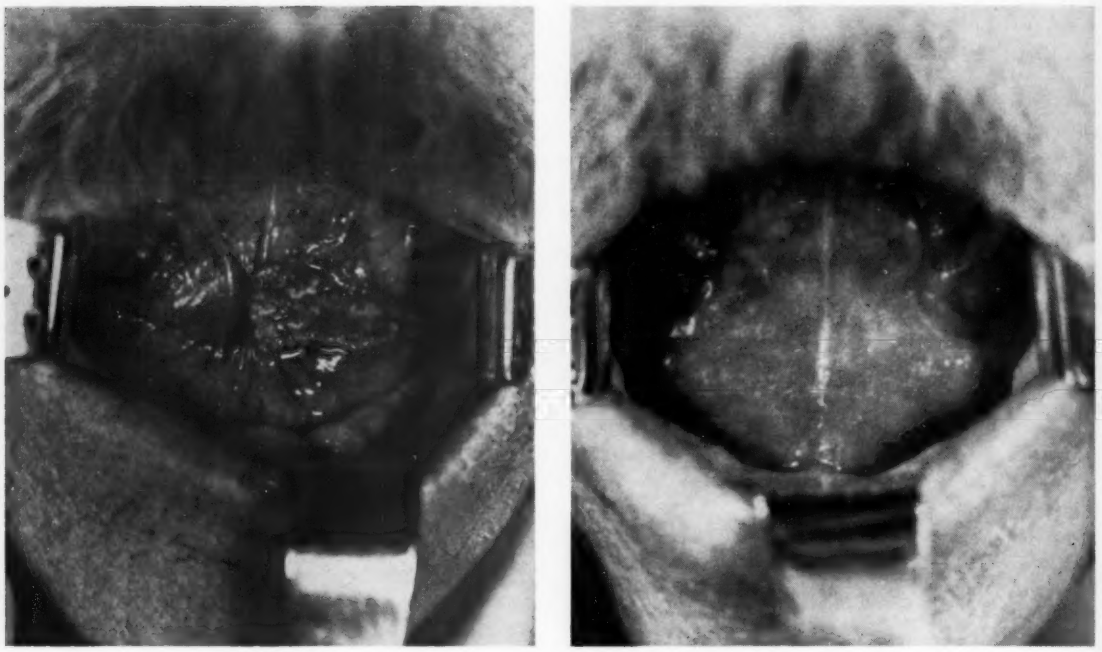

Fig. 5. Cancer of the floor of the mouth. Teleradium and intraoral roentgen irradiation. Five years, no recurrence.

inactive for a period, and in some instances, regress, so that their subsequent excision is more readily undertaken.

Intraoral Irradiation. Intraoral irradiation has been delivered by means of a periscopic attachment to a 200 kv. machine with a half-value layer of 0.9 mm. Cu, and an output of 29 r, at a distance of 50 cm.

In a typical case treated by roentgen therapy, a four-portal technique is used externally and treatments given in amounts of 300 r as measured in air through a 4 by 5 cm. or a 6 by 8 cm. portal. A tumor dose of 4,600 r in twenty-eight days is achieved. At the end of the first cycle of treatments, the intraoral roentgen therapy is commenced, daily doses of 250 r in air being given and achieving a dosage to the tumor area varying from 1,500 to 2,800 r, the total dosage obtained being of the order of 6,000–7,000 r in four to five weeks.

Occasionally in very superficial lesions,

Table VI

CARCINOMA OF TONGUE

1929–1947

Control of Primary Lesion by Initial Treatment

Method of Treatment	Total*		Early Cases		Late Cases	
	No. of Cases	% Controlled	No. of Cases	% Controlled	No. of Cases	% Controlled
Interstitial Radium	159	60.4%	110	70.0%	49	38.8%
External Radiation	152	32.9%	55	52.7%	97	21.7%
Combination	66	63.6%	26	84.6%	40	50.0%
Total	377	49.9%	191	67.0%	186	32.3%

* Excluding 8 cases not treated and 9 cases in which the condition of the primary lesion was not known.

TABLE VII

CARCINOMA OF FLOOR OF MOUTH

1929–1947

Control of Primary Lesion by Initial Treatment

Method of Treatment	Total*		Early Cases		Late Cases	
	No. of Cases	% Controlled	No. of Cases	% Controlled	No. of Cases	% Controlled
Interstitial Radium	19	63.2%	15	73.3%	4	25.0%
External Radiation	50	28.0%	24	37.5%	26	19.2%
Combination	24	41.7%	12	41.7%	12	41.7%
Total	93	38.7%	51	49.0%	42	26.2%

* Excluding 1 case not treated and 1 case in which the condition of the primary lesion was not known.

particularly in the elderly patient, treatment has been given quickly by means of an intraoral cone with roentgen rays generated at 88 kv. This has the advantage of a very short treatment time and an effective dosage can be obtained, providing the lesions are early and superficial. A total dosage of 5,000 to 6,000 r in ten days is aimed at.

Teleradium. A 4 gram modified Sievert unit with a pneumatic load is in use. The advent of teleradium to a large extent replaced the use of radium molds externally. Its chief use has been in treatment of lesions in the floor of the mouth and in the posterior portion of the tongue.

Radium Molds. Radium molds were used in the early cases in this series, particularly in the treatment of the floor of the mouth to supplement interstitial implantation of needles, but more recently have been reserved for superficial lesions involving the gingivae.

TABLE VIII

CARCINOMA OF TONGUE

1929–1947

Control of Recurrent Primary Lesions by Subsequent Treatment

Early Lesions	Number	Late Lesions	Number
Controlled	12	Controlled	5
Uncontrolled	20	Uncontrolled	16
Total	32	Total	21

Radon Seeds. Radon seeds have been used in this series in the treatment of residual masses following previous irradiation, or in early lesions in elderly patients who, it is felt, would not tolerate a radium needle implant. We feel that they do have the distinct disadvantage of a high dosage effect immediately about the seed, causing a local necrosis, and unless the seeds are buried very deep, they tend to work their way out, giving rise to considerable discomfort. It is important that distribution of the seeds be carefully planned beforehand so that an even dosage may be accomplished throughout the entire area.

Radium Needles. Needles most commonly in use for intraoral lesions are those having a linear intensity of 0.66 milligrams and 0.33 mg. per centimeter of length, with a wall thickness of 0.5 mm. of platinum. The usual loading is 1 and 2 mg. Shorter 1 mg. needles of a linear intensity of 0.66 mg.

TABLE IX

CARCINOMA OF FLOOR OF MOUTH

1929–1947

Control of Recurrent Primary Lesions by Subsequent Treatment

Early Lesions	Number	Late Lesions	Number
Controlled	8	Controlled	4
Uncontrolled	10	Uncontrolled	6
Not treated	1	Not treated	1
Total	19	Total	11

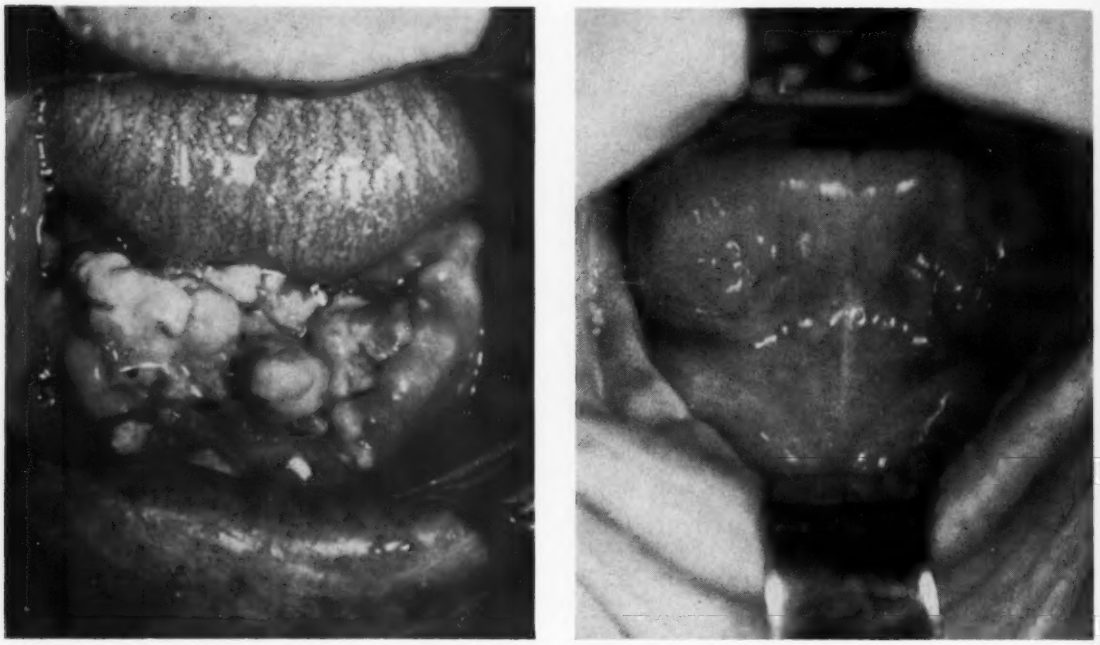

Fig. 6. Cancer of the floor of the mouth. External roentgen irradiation plus radium implant. Ten years, no recurrence.

per centimeter are also available. The needles are sutured in place with chromic gut and left in situ for the required time, 6,000 to 6,700 gamma roentgens delivered in four to six days. The early implants in this series were carried out using radium needles of only one linear intensity (0.66 mg. per centimeter), usually arranged in a palisade manner. A relatively high central dose was thus incurred, resulting, at times, in dense scar formation or even chronic ulceration. By crossing the ends and employing half-strength needles in the central part of the implant, these effects have almost disappeared in our cases (see Fig. 2).

SURVIVAL

While this paper deals primarily with radiotherapy of carcinoma of the tongue and floor of the mouth, nevertheless it is felt that a statement of survival in this series would be of interest. This is given in Tables III and IV. Table V indicates in general the staging that has been used in this series. It must be noted that these tables represent the combined efforts of

Table X

CARCINOMA OF TONGUE

1929–1947

Control of Primary Lesion

Stage	Number*	Controlled	% Controlled
Early	195	150	76.4%
Late	195	69	35.4%
Total	390	219	56.2%

* Untraced cases excluded—4.

Table XI

CARCINOMA OF FLOOR OF MOUTH

1929–1947

Control of Primary Lesion

Stage	Number*	Controlled	% Controlled
Early	51	37	72.5%
Late	43	15	34.9%
Total	94	52	55.3%

* Untraced cases excluded—1.

the radiotherapist and the surgeon in this series. With very few exceptions, however, the primary lesion has been treated by radiotherapy, and as indicated previously, surgery has been largely limited to dealing with metastatic nodes in the neck.

RESULTS OF RADIOTHERAPY TO THE PRIMARY LESIONS

An attempt has been made in Tables VI and VII to assess the effectiveness of the initial treatment of the primary lesion. By initial treatment is meant treatment which has been accomplished within three months. "Controlled" indicates that the primary lesion has remained healed for a period of five years or until the time of death. From this it would seem that the most effective method of dealing with the primary lesion is by interstitial radium or a combination of this with some form of external irradiation. External irradiation alone, which includes teleradium and intraoral roentgen therapy, gives the poorest results.

Even when initial treatment has failed it is possible that further radiotherapy may still hold a chance of cure as shown in Tables VIII and IX. Finally, Tables X and XI indicate the control of the primary lesion by radiotherapy in the entire series. This includes those cases in whom the initial treatment failed but subsequent treatment proved successful.

SUMMARY

(1) The initial treatment of the primary lesion in cancer of the tongue and floor of the mouth would seem to be best accomplished by radiotherapy.

(2) Better results appear to attend the use of radium, or a combination of interstitial radium and roentgen rays, than is the case when external therapy is used alone.

(3) By crossing the open ends of the radium implant with full strength needles and using half strength needles in the central portion of the implant, a more even dosage distribution is obtained with resultant diminution of undesirable sequelae.

(4) Electrocoagulation may be useful at the time of initial treatment as an adjunct to radiotherapy.

(5) Studies at present are being made as to the value of extending the field of surgery in the so-called radiation failures—particularly when initial treatment has failed and the lesions remain localized.*

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* For discussion see page 635.

THE SURGICAL TREATMENT OF CANCER OF THE BUCCAL MUCOSA AND LOWER GINGIVA*

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CANCERS of the buccal mucosa and lower gingiva exhibit similar behavior patterns, with secondary invasion of the mandible and metastases to the upper cervical lymph nodes a common occurrence. Since 1944 the majority of these patients have been treated by surgical rather than irradiation methods at The Ellis Fischel Cancer Hospital, the change in treatment being the result of application of the principle of resection of the primary lesion and its lymphatic drainage area in continuity. This principle, long applied in the surgery of other types of cancer, was first used in the treatment of cancer arising in the oral mucosa by Kocher, Bloodgood, Semken, and others. It fell into disuse as a result of excessive mortality and morbidity, together with the advent of the science of irradiation. Advances in the ancillary surgical sciences have recently permitted the performance of en bloc resection of the primary lesion, a portion of the mandible, and the cervical lymph nodes with a satisfactorily low operative risk and morbidity. Since the first jaw-neck dissection procedure was performed at The Ellis Fischel Cancer Hospital in 1940, a total of 110 such operations have been performed for all types of oral cancer.† This report is limited to the results of treatment in a series of 63 previously untreated patients with epidermoid cancer of the buccal mucosa and lower gingiva who were treated surgically between 1940 and 1950. Thirty-six of these patients were treated by means of the jaw-neck dissection operation.

† These operations were performed by Drs. Eugene Bricker, Everett Sugarbaker, and John Modlin, who successively directed the Department of Surgery of The Ellis Fischel Cancer Hospital during the period covered by this survey.

MATERIAL

Between May, 1940 and August, 1950 a total of 125 *previously untreated* patients with cancer of the buccal mucosa and lower gingiva were examined (Table 1). Of these, 48 were treated by irradiation, 63 by surgical means, and 14 received no treatment. It is emphasized that only primary (previously untreated) cases are included, and that no patients were lost to follow-up. Although this report deals exclusively with the surgically treated cases, it is interesting that during the first four years of operation of the hospital, 28 of 35 patients were treated by irradiation, while during the period between 1946 and 1950, 31 of 38 similar patients were treated surgically, thus illustrating the trend toward surgical management.

Of the 63 surgically treated patients, 31 had lesions primary in the buccal mucosa and 32, in the lower gingiva. There proved to be little difference in the behavior pattern of these tumors with the exception that invasion of the mandible, as might be expected, occurred more frequently in the patients with gingival cancer. Twenty-three of the 32 gingival lesions exhibited such invasion, while only 5 of the 31 buccal

TABLE I

CANCER OF THE BUCCAL MUCOSA AND LOWER GINGIVA; 125 PRIMARY CASES 1940–1950

	Cases
Irradiation	48
Surgery	63
No treatment	14

1940–1944 28 of 35 patients treated by irradiation.
1946–1950 31 of 38 patients treated by surgery.

* Presented in a Symposium on Treatment of Cancer of the Oral Cavity at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

Table II

CANCER OF THE BUCCAL MUCOSA AND LOWER GINGIVA SURGICALLY TREATED PRIMARY CASES

Total Patients	Bone Invasion	Lymph Node Metastases
63	28 (46%)	12 (19%)

lesions invaded bone. Histopathologically proved lymph node metastases occurred in 12 instances (19 per cent) (Table II). The 19 per cent rate of lymph node metastases is undoubtedly low since it does not include clinically diagnosed metastases in 7 of 14 untreated patients. In addition, there may have been unobserved late metastases in some of the patients who died with cancer.

CLINICOPATHOLOGIC CORRELATION

Most reports of a correlation between histopathologic grade and clinical behavior of malignant tumors are unconvincing. The reader has no assurance that precautions were taken to conceal from the grader all clues to the stage of the disease. In this regard we would point out that the section examined may contain such clues in terms of size of the tumor and involvement of contiguous structures.

In an effort to obtain an unbiased correlation, we conducted the following experiment: The material consisted of all cases of epidermoid carcinoma arising in the mucosa of the cheek and lower gingiva that were capable of five year follow-up and that had been biopsied prior to treatment. Seventy cases fulfilled these requirements.* The original slides from these biopsy specimens were thoroughly mixed and then examined, and the grade recorded. One month later, the process was repeated. The same person did the grading on both occasions. He had never seen the slides prior to the experiment. On each occasion the tumors were classified in four categories:

I. Well differentiated
II. Intermediate
III. Poorly differentiated
N.D. Not diagnostic of cancer

Table III

CORRELATION TABLE FROM AN EXPERIMENT IN HISTOPATHOLOGIC GRADING. SEE TEXT FOR DETAILED DESCRIPTION

Initial Grade	Final Grade				Initial Total
	I	II	III	N.D.	
I	*23*	1		1	25
II	12	*13*	2		27
III		3	*11*		14
N.D.				*4*	4
Final Total	35	17	13	5	70

Table IV

PROPORTION OF CASES IN THE LIMITED STAGE ACCORDING TO HISTOPATHOLOGIC GRADE

Grade	Initial		Final	
	No.	Per cent	No.	Per cent
I	20/25	80	28/35	80
II	19/27	70	13/17	76
III	9/14	64	7/13	54
Total	48/66	73	48/65	74

The results are shown in Table III. The important feature to note is that only in 51 of the 70 cases was the initial grade reproduced in the second (or final) grading. This large discrepancy is due principally to the difficulty of defining the intermediate group. At the ends of the grading spectrum we were more successful, being consistent with 23 of 25 well differentiated tumors and 11 of 14 poorly differentiated tumors.

In examination of the relation between these two estimates of the histopathologic grade and the behavior of the tumors, the stage of the disease on admission should first be considered. The term "limited stage" refers to those cases in which the primary lesion appeared to be surgically resectable and the regional lymph nodes were clinically uninvolved. The relation of the histopathologic grade to the proportion

* Includes patients treated by irradiation.

Table V

ABSOLUTE FIVE YEAR SURVIVAL RATE FOR CASES IN THE LIMITED STAGE ACCORDING TO HISTOPATHOLOGIC GRADE

Grade	Initial		Final	
	No.	Per cent	No.	Per cent
I	11/20	55	13/28	46
II	7/19	37	4/13	31
III	0/9	0	1/7	14
Total	18/48	38	18/48	38

Table VI

ABSOLUTE FIVE-YEAR SURVIVAL RATE FOR SURGICALLY TREATED CASES IN THE LIMITED STAGE ACCORDING TO HISTOPATHOLOGIC GRADE

Grade	Initial		Final	
	No.	Per cent	No.	Per cent
I	6/10	60	7/14	50
II–III	2/9	22	1/5	20
Total	8/19	42	8/19	42

of cases in the limited stage is shown in Table IV. It appears that the poorly differentiated tumors tend to present themselves for treatment in a more advanced stage.

The next point to be considered is the relation between histopathologic grade and rate of survival. The obvious effect of difference in stage of disease on admission should, of course, be eliminated. For this purpose, in Table V only cases in the limited stage have been considered. There is very steep decline of the absolute five year survival rate as the tumor becomes less differentiated. This means that the response to treatment varies with the degree of differentiation.

All cases were included in Table V without regard to the methods of treatment employed. The gradient then represents a variation in response to the total treatment program. To elucidate its mechanism, we must deal with cases in which the method of treatment was essentially the same. This has been done in Table VI. From the cases in the limited stage, we selected those in which the original treatment was some surgical procedure. This covers the range from simple excision to the jaw-neck dissection operation. The Grades II and III have been combined because of the small numbers involved. The variation in response to treatment is still present.

What does this variation in response to surgical treatment mean? A simple explanation is that it reflects variation in the true extent of the tumor at the time of treatment. In particular, we have in mind occult infiltration and metastasis beyond the field selected for excision and not detectable by clinical examination. In this respect, the rate of local control is of considerable interest. Of the 10 Grade I cases (initial grading), there was uncontrollable recurrence at the primary site or in the regional lymph nodes in 3 instances. One additional case died of intercurrent disease. Of the 9 Grade II–III cases, there was uncontrollable recurrence in 3 instances. In addition, there was 1 operative death and 3 deaths from intercurrent disease without evidence of cancer. Thus, if we exclude operative deaths and deaths from intercurrent disease as being indeterminate, we have local control for five years in 6 of 9 Grade I, and 2 of 5 Grade II–III cases. This gradient from 67 to 40 per cent is not as impressive as the 60 to 22 per cent gradient in Table VI. Furthermore, both of them are based on small numbers of cases.

The possibility exists that a stronger correlation may be obtained by using sections of the resected tumor rather than of the biopsy. An example of this is seen in verrucous carcinoma of the oral mucosa as described by Ackerman. We have encountered two difficulties that restrict the usefulness of this entity in our hands. The first is that we cannot make the diagnosis with confidence from biopsy specimens. The second is that the larger the tumor, the easier it is for us to find areas in which the histopathologic structure is equivocal.

Both of these difficulties involve the

problem of a workable definition of the term "verrucous carcinoma," as distinct from well differentiated epidermoid carcinoma. The superficial papillary growths which appear as small "buttons" on the lip and as thick, white plaques in the oral mucosa are, to us, clearly verrucous clinically and microscopically, although there may be doubt as to whether or not they are even malignant. The bulky, ulcerated tumors of the cheek and lower gingiva are, on the other hand, similar in clinical appearance, whether microscopically verrucous or less well differentiated.

A word of caution is in order regarding the use of the histopathologic grade in planning treatment. Correlations of the type shown in Table VI can be readily demonstrated for most forms of cancer, using such clinical features as duration of symptoms, or size, or fixation, in place of histopathologic grade. Hence, to obtain an unbiased estimate of the grade, it becomes necessary to restrict the information supplied to the pathologist to the minimum required for orientation. Such a procedure delegates to him the role of a technician rather than a physician. In our opinion, the interests of the patient are better served by providing the pathologist with the full particulars so that he may assist in detecting discrepancies between the clinical and histopathologic findings.

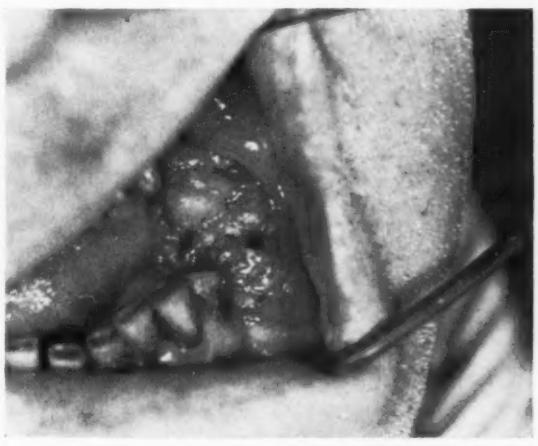

FIG. 1. Epidermoid carcinoma of lower gingiva. Bone invasion.

FIG. 2, Epidermoid carcinoma of buccal mucosa, adjacent to (but not invading) bone.

SURGICAL PRINCIPLES AND INDICATIONS FOR JAW-NECK DISSECTION

The mandible is frequently invaded by cancer arising in the buccal mucosa and lower gingiva (Fig. 1), and in the surgical treatment of such patients sacrifice of a portion of the mandible is obligatory. In our opinion, surgical excision of the involved bone is superior to treatment by means of irradiation. In lesions without mandibular involvement (Fig. 2) sacrifice of a portion of the mandible should be carried out without hesitation, the principle of wide excision of the primary lesion and its lymphatic metastases being the prime requisite rather than considerations of function or esthetics.

It is emphasized that we rarely employ the actual cautery in the treatment of these lesions. In our opinion, wide scalpel excision is to be preferred since it is doubtful if cauterization of tissues which cannot be emcompassed by clean surgical dissection will salvage many patients. Healing by primary intention rarely occurs following use of the cautery, while it is the rule in these cases after sharp knife dissection.

Fig. 3. Epidermoid carcinoma of buccal mucosa. Subdigastric lymph node metastasis.

Not only should there be radical resection of the primary lesion and unhesitant sacrifice of a portion of the mandible, but attention should be given also to the widest possible resection of the cervical lymphatics (Fig. 3). With the present low mortality following the jaw-neck dissection operation, partial removal of the cervical lymph nodes, as in the upper neck type of dissection, should be applied only in exceptional cases. The radical neck dissection begins at the clavicle and includes removal of the sternomastoid muscle and the internal jugular vein. Division and removal of the digastric and stylohyoid muscle, the eleventh cranial nerve, and the external carotid artery with some of its branches should be carried out without hesitation if dictated by extension of the tumor or its metastases.

Slaughter has aptly divided the indications for the jaw-neck dissection procedure into absolute and relative categories. We agree that the absolute indications include situations where mandibular involvement and/or lymph node metastases are present. In such patients radical surgery will unquestionably salvage a greater percentage than will irradiation methods. At The Ellis Fischel Cancer Hospital several of these patients have been permanently salvaged by the jaw-neck procedure following previous unsuccessful irradiation.

It is in patients with smaller lesions (Fig. 4) that relative indications for the operation exist. It is granted that competent irradiation will undoubtedly control many such patients; however, in the light of previously mentioned results in advanced cases in this series, it is our conviction that the jaw-neck operation should now be applied to these smaller lesions.

Ward and Robben have emphasized that the lymphatics of the tongue and floor of the mouth pass through the periosteum of the mandible on their way to the cervical lymphatics and that this constitutes a definite indication for sacrifice of the mandible whenever the primary growth extends close to this bone. In our opinion, an even more important reason for observance of the principle of en bloc resection of the primary growth, mandible, and cervical lymph nodes is the fact that wide exposure of the primary lesion is thereby effected, permitting a much wider removal of the primary growth than could be obtained by older methods. Clinical experience has borne out the contention that these cancers metastasize by embolization rather than by direct permeation along lymphatics. Although difficult to prove, it is possible that it is the wider exposure and accessibility of the primary lesion that has so markedly improved the survival rate.

Sacrifice of a portion of the mandible and the cervical lymph nodes in the patient

Fig. 4. Small epidermoid carcinoma of buccal mucosa.

with a relatively small lesion is a small price to pay for improvement of the admittedly poor rate of control achieved by previous methods of treatment.

RESULTS

In the group of 36 patients with cancer of the buccal mucosa and lower gingiva who were treated by means of the jaw-neck dissection operation (Table VII), histopathologically verified invasion of the mandible was present in 18, or 50 per cent. Histopathologically proved lymph node metastases were present in 8 patients, or 22 per cent, of the operative specimens. Of the patients with lymph node metastases, 4 (50 per cent) are alive and free of disease following operation for periods of at least three years. Eleven of 23 patients capable of a five year follow-up, and 17 of 36 capable of three year follow-up were alive and free of disease at the time of this study, or a five and three year absolute survival rate of 47 per cent for the jaw-neck dissection operation when applied to carcinoma of the buccal mucosa and lower gingiva.

There were 3 postoperative deaths in the group of 36 patients, or an operative mortality of 8 per cent. The over-all operative mortality in the total of 110 jaw-neck dissection procedures which have been performed at The Ellis Fischel Cancer Hospital to date has been 6 per cent. The present operative risk is considerably lower, since the latter figure includes earlier operations performed during the pioneering period for this procedure, many in patients with advanced recurrent disease.

TABLE VII

CANCER OF THE BUCCAL MUCOSA AND LOWER GINGIVA
JAW-NECK DISSECTION OPERATIONS
36 PRIMARY CASES 1940–1950

	Total	Per Cent
Bone invasion	18	50
Lymph node metastases	8	22
Operative deaths	3/36	8
3 year absolute survivals	17/36	47
5 year absolute survivals	11/23	47

Of the 63 surgically treated patients, 27 were treated by local surgical resection (without concomitant resection of the mandible and cervical lymph nodes). The majority of these lesions were of a comparatively small size. However, many of them were treated during the early years of the hospital and, in view of later experience, in all probability would be treated by means of jaw-neck dissection at the present time. The three and five year results in the group treated by local resection are nevertheless surprisingly good. Eleven of 19 patients capable of a five year follow-up and 17 of 27 capable of a three year period of follow-up survived and were free of disease. The five and three year survival rates are 56 per cent and 62 per cent, respectively.

DISCUSSION

Within another few years a sufficient number of patients with cancer of the oral mucosa will have been treated according to the principle of combined en bloc resection of the primary cancer and its extensions to permit accurate evaluation of its curative capabilities. If the results fail materially to exceed those obtained by irradiation methods then, of course, the procedure should be reserved for irradiation failures. The experience at The Ellis Fischel Cancer Hospital now includes a total of 110 jaw-neck dissection operations performed for all types of cancer about the oral mucosa, the majority being for cancer of the buccal mucosa and lower gingiva and for lymph node metastases from cancer of the lower

TABLE VIII

COMBINED JAW-NECK DISSECTIONS
110 OPERATIONS 1940–1953

	Number	5 Year Survival Rate
Capable of five year follow-up	42	48% (20/42 patients)
Lymph node metastases	24	37%
Bone invasion	22	50%
Salvage cases (26 total cases excluding lip)	13	38%

Fig. 5

Fig. 6

Fig. 7

Fig. 5, 6 and 7. Appearance following jaw-neck dissection.

lip which have secondarily involved the mandible. The three and five year results in this larger group closely parallel those just reported for lesions arising in the buccal mucosa and lower gingiva (Table VIII). Of the total of 110 patients, 42 are capable of a five year period of follow-up. Thirteen of 42 patients were salvage cases with a history of previously unsuccessful treatment, 22 exhibited histopathologically proved invasion of the mandible, and 24 of the 42 (57 per cent) exhibited lymph node metastases. The over-all absolute survival rate for the group of 42 patients capable of a five year follow-up was 20 of 42, or 48 per cent. This figure, together with the absolute survival rate of 47 per cent for the 23 five year patients with gingival and buccal cancer, is highly encouraging. In our opinion, it is indicative of an almost certain superiority of surgical over irradiation methods in the treatment of oral cancer arising in these particular locations, and there is little question that continued investigation of the jaw-neck dissection operation is in order. It is emphasized that these remarks apply only to the treatment of cancer arising in the buccal mucosa and lower gingiva and for metastases invading the mandible secondary to cancer of the lip. Our experience with this procedure in the treatment of cancer arising in the tongue and floor of the mouth is relatively meager since there is a scarcity of these lesions at The Ellis Fischel Cancer Hospital.

A vigorous follow-up system has been maintained with patients returning for examinations at regular intervals. We are convinced that the mortality and morbidity of this operation is not so great that it should be considered a deterrent to its use. From our follow-up observations, it is now obvious that sacrifice of a portion of the mandible is not particularly serious nor disabling and that the overwhelming majority of patients are able to maintain an excellent nutritional state (Fig. 5, 6 and 7). One of the disabling features has been the inability to comfortably wear false dentures. As a consequence, these patients are unable to chew tough foods. Also, when malignant involvement of the overlying skin has necessitated a large oral fistula, results are far less satisfactory and reconstruction in these patients, fortunately a minority, has proved to be a formidable task.

SUMMARY

The results of surgical treatment of epidermoid cancer of the buccal mucosa and lower gingiva of sixty-three previously untreated patients are recorded. While further experience with application of the principle of en bloc resection of the primary lesion, mandible, and cervical lymph nodes is needed in order to evaluate accurately this form of treatment, the results to date have indicated a decisive superiority over previous methods of treatment. If the five year absolute control rate of 47 per cent obtained in this series of twenty-three jaw-neck dissection operations for carcinoma of the buccal mucosa and lower gingiva continues to be maintained in the future, it would seem that this operation should be applied as the initial form of treatment in patients with smaller lesions. Sacrifice of a portion of the mandible and the cervical lymph nodes is compatible with a relatively normal and happy existence and should not be regarded as a deterrent to the application of this principle of treatment even in the patient with a small cancer arising at these locations.*

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* For discussion see page 635.

RADIATION THERAPY OF CANCER OF THE BUCCAL MUCOSA AND LOWER GINGIVA*

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FOR this symposium, I have been asked to discuss cancer of the buccal mucosa and cancer of the lower alveolar mucosa from the radiotherapeutic standpoint. The discussion will be based on the material seen and treated in our department during the years 1940 to 1951 inclusive, and which represents my personal experience with these lesions. During this period, 50 previously untreated cases of cancer of the buccal mucosa and 7 cases with recurrent lesions following surgical or radiation treatment elsewhere were irradiated. In the same period, 44 patients with cancer of the lower alveolar mucosa were treated. Four had recurrent lesions following treatment elsewhere and 1 left for treatment elsewhere, leaving 39 primary cases. Only the primary cases will be considered. During the same period 94 primary cases of cancer of the oral part of the tongue and 47 cases of cancer of the floor of the mouth were treated.

CANCER OF THE BUCCAL MUCOSA

As is usually the case, well differentiated squamous cell carcinomas were predominant in this series of 50 cases: 8 were classified histopathologically as Grade 1 and 28 Grade 2, whereas 13 were Grade 3 and 1 was ungraded. The morphologic types included flat plaque-like whitish lesions (Fig. 1) of obvious leukoplakic origin, exophytic tumors (Fig. 2), warty nodular growths (Fig. 3) and infiltrating ulcerative lesions (Fig. 4 and 5, *A* and *B*). There was only 1 female in this series.

Ten of the lesions were advanced to the extent of involving essentially the entire buccal mucosal area and some of these extended beyond this region. Fourteen lesions were small, measuring 3 cm. or less in diameter. In 7 instances the carcinoma had infiltrated through the entire thickness of the cheek to appear externally. The posterior third of the buccal surface, a location of known poorer prognosis than the more anterior portions, was involved in at least 23 of the 50 cases.

Eleven patients (22 per cent) presented metastases on admission, the metastases being located near the angle of the mandible or further anteriorly in the submaxillary area. The fate of these patients may be detailed here. Treatment failed in 8 of the 11 patients; the longest survival was fourteen months. Although surgical dissection is our favored approach for the treatment of metastasis of this lesion, in only 2 of the 8 was this feasible, the remaining 6 patients were treated by external irradiation. Of the other 3 patients, 1 treated by roentgen irradiation only died without recurrence six and one-half years after treatment at the age of eighty-one years. One patient had a suprahyoid neck dissection performed for a submaxillary metastasis, but four months later developed a preauricular metastasis which was irradiated; four years later the patient died without recurrence at the age of ninety, of a coronary thrombosis. The last patient alive eleven and one-third years after treatment had a suprahyoid neck dissection following roentgen treatment which was directed both to the primary and to the submaxillary metastasis. Microscopic examination showed only necrotic carcinoma to be left in the involved node.

Five patients initially free of metastasis developed such metastasis later, the longest interval being nine months. Four of these

* From the Department of Radiology, University of Michigan, Ann Arbor, Michigan. Presented in a Symposium on Treatment of Cancer of the Oral Cavity at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

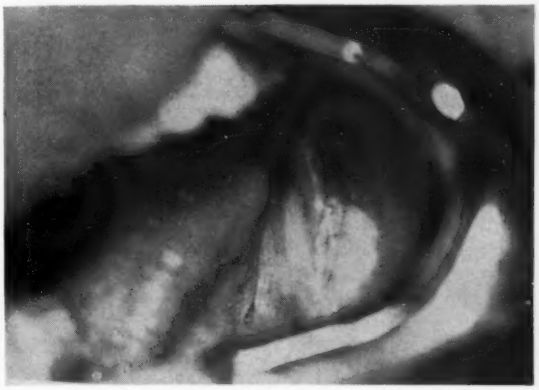

Fig. 1. Plaque-like whitish lesion in lower part of left buccal mucosa extending onto the lower alveolar ridge in a seventy-one year old male, histopathologically cornifying squamous cell carcinoma, Grade 2. External roentgen irradiation through a single field over a period of thirty days. Patient died five and one-half years after treatment without recurrence.

patients were treated, 1 surgically and 3 by external irradiation but treatment failed. One patient did not return for treatment and died at home.

With the exception of 1 patient successfully treated by irradiation for a carcinoma of the floor of the mouth eleven years before, and whose buccal lesion was treated by interstitial radium, all the patients received roentgen treatment. Thirty-three

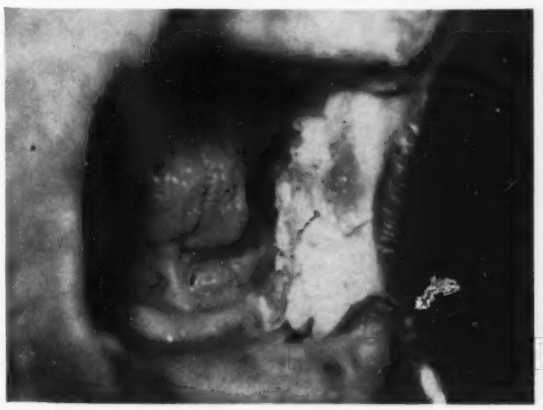

Fig. 2. Large tumor involving most of the left buccal mucosal surface in a seventy-eight year old male, which was treated by external irradiation only. At the last follow-up, twenty-five months after treatment, there was no evidence of recurrence.

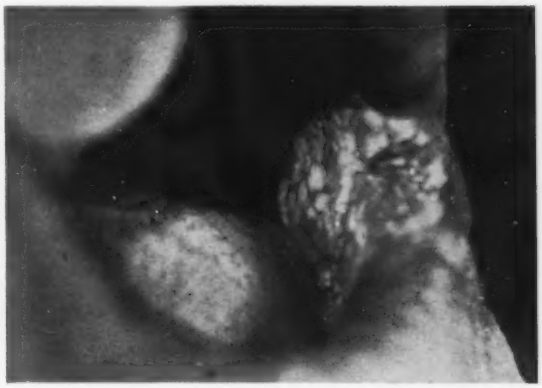

Fig. 3. A cornifying squamous cell carcinoma, Grade 2, involving most of the left buccal mucosal surface in a seventy-six year old male. The left oral commissure is involved and the neoplasm has grown through the entire thickness of the cheek to appear externally. External roentgen irradiation through a single field over thirty-two days produced complete regression. At the last follow-up, six months after treatment, no recurrence was present.

were treated by external irradiation only, using a 200 kv. beam of half-value layer 1.0 mm. Cu at a distance of 50 cm. Seven patients were treated by peroral roentgen irradiation, in addition to external irradiation. Nine patients received only peroral roentgen irradiation. For the peroral treatment, a 200 kv. beam of half-value

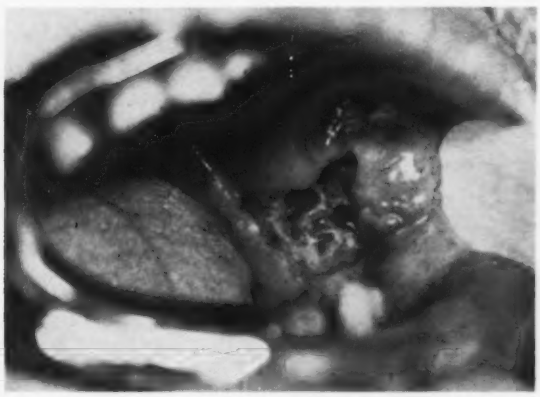

Fig. 4. Extensive infiltrative lesion of the entire left buccal mucosa with ulceration and a large fixed metastatic node at left angle of mandible in a sixty-one year old male, histopathologically cornifying squamous cell carcinoma, Grade 3. Radiation treatment failed and patient died eight months later.

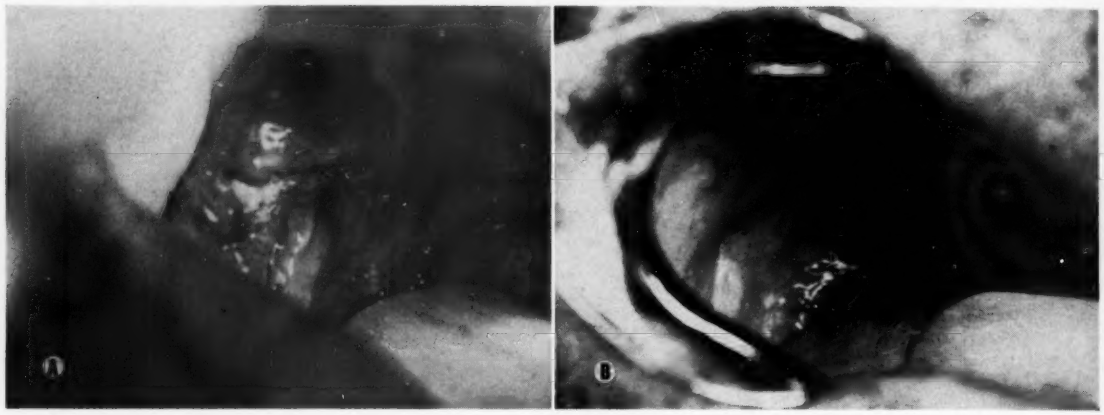

Fig. 5. (*A*) Ulcerative infiltrative lesion of the posterior half of the right buccal mucosa in a sixty-one year old male, histopathologically a cornifying squamous cell carcinoma, Grade 2. This lesion was treated solely by peroral irradiation using a 200 kv. beam of half-value layer 0.75 mm. Cu at 26 cm. distance to a total air dose of 6,300 r over a period of three weeks. (*B*) Same case four months after treatment. This patient died without recurrence eight and five-sixth years after treatment.

layer 0.75 mm. Cu was employed at a distance of 26 cm. or 35 cm., with the exception of three small lesions treated in the earlier years of this series over a period of several days with a 150 kv. unfiltered beam. Treatment was protracted over three to six weeks, the tissue doses being essentially uniformly scattered about a straight line connecting the point of 5,200 r in three weeks with that of 7,000 r in six weeks.

The results of treatment are presented in two ways. Of the 50 cases, 30 are eligible for calculation of a five year survival rate. Fifteen were alive without neoplasm at five years. On this basis, the five year survival rate is 50 per cent. However 2 patients died of intercurrent disease without neoplastic recurrence at four and one-fourth and four and one-half years after treatment. These may be considered as indeterminate cases, leaving 28 determinate cases with 15 survivors, a survival rate of 53.6 per cent.

The second method of determining survival rate consists of an estimate based on the entire group of 50. In Figure 6 each case is represented by a dot which in relation to the horizontal coordinate indicates duration of survival after treatment. The dots appear in 4 groups, D indicating those patients dead with neoplasm or with no assurance to the contrary, D_1 representing the patients dying of other causes without evidence of recurrent carcinoma of the buccal mucosa or of metastasis from this lesion, A standing for alive without neoplasm and $A_{\bar{c}}$ alive with neoplasm. These data are utilized in an actuarial method of computing the probability of a patient escaping death from cancer within any given period of time subsequent to treatment. Such probabilities may be computed for the cases at risk of death for the first and then for each successive year thereafter until the fifth year. The product of the probabilities through the fifth year gives

Table I

Carcinoma of the Buccal Mucosa Reported Results; Radiation Treatment

	No. Patients	Per Cent 5 Year Survival Rate
Richards,[8] 1940	55	50.9
Martin, C. L.,[3] 1940	35	40.0 ($2\frac{1}{2}$ to 9 yr.)
Paterson *et al.*,[5] 1946 (Radium)	70	46.0
Perussia,[7] 1949	212	41.0
Cade,[1] 1949 (Radium)	18	61.0
Ledlie and Harmer,[2] 1950	59	16.5
Paterson *et al.*,[6] 1950 (Radium)	82	57.0

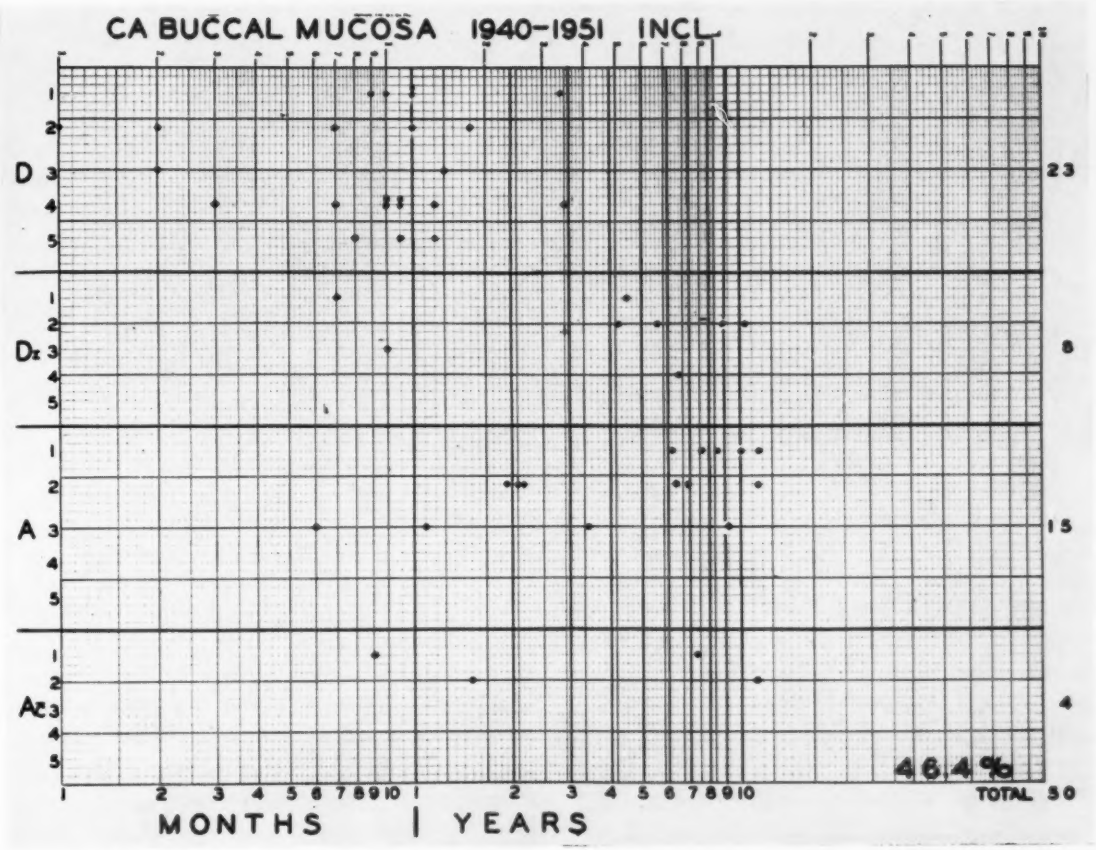

FIG. 6. Dot graph on semi-log paper of survival and status for the 50 cases of carcinoma of the buccal mucosa. Each patient is represented by a dot which in relation to the horizontal axis indicates duration of survival after treatment. The dots are divided into 4 groups: *D* indicating the patients dead with neoplasm or with no assurance to the contrary, *D*1 representing patients dying of other causes without evidence of neoplasm, *A* standing for those alive without neoplasm and *Ac* alive with neoplasm.

the probability of survival at the end of the fifth year.[5,9] For this series the estimated five year survival rate is 46.4 per cent. It is probable that this is a firmer survival rate than that based on the 30 patients available for five year survival rate computation.

In the recent literature, not many survival rates are to be found for carcinoma of the buccal mucosa in which the primary tumor was treated solely by radiation methods. In many instances this lesion is grouped with other oral carcinomas and it is not possible to isolate the results of treatment of this lesion. In other reports, both surgical and radiation methods of treatment have been used on the primary tumor. In Table 1 are tabulated some of the reports to be found in the literature since 1940.

CANCER OF THE LOWER GINGIVA

Of the 39 cases of primary cancer of the lower alveolar mucosa, 33 were in males and 6 in females. Nearly all the lesions were well differentiated squamous cell carcinomas, 33 were classified as histopathological Grade 2, 3 as Grade 3; 3 were not graded.

Eight of the tumors were 3 cm. or less in diameter, 9 were larger but still confined to the alveolar mucosa. Thirteen had extended beyond the gingiva to involve regional structures but without metastatic involvement. An example of an advanced lesion extending to involve the floor of the mouth is shown in Figure 7, *A* and *B*. Clinically invasion of the mandible was clearly present but since no roentgenograms were

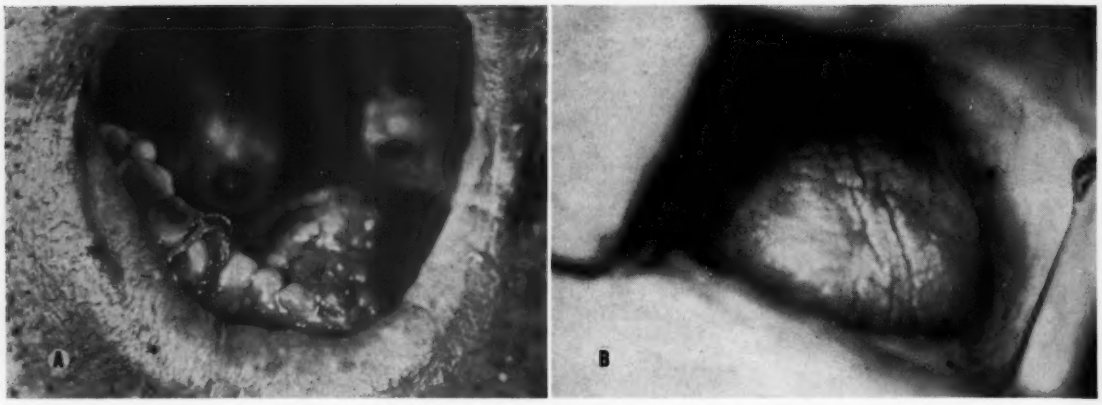

Fig. 7. (*A*) An extensive lesion involving the lower anterior and the entire left lower alveolus. The two carious teeth poorly seen in the left lower jaw are embedded in a carcinomatous mass. Clinically there was clear evidence of bone invasion of the mandible but since roentgenograms were not obtained this patient is not included in the group with bone invasion. (*B*) Same patient, four and one-half years after treatment.

obtained, this patient is not included in the group with bone invasion. Nine cases presented lymph node metastases. It is of interest that indisputable roentgenographic evidence of invasion of the mandible (Fig. 8 and 9) was present in 14 cases (35.9 per cent).

Of the 9 patients with lymph node metastasis on admission, although neck dissection is considered the preferred method of treatment, none were operated on because of advanced age, advanced status of the primary lesion or the advanced status of the metastatic disease. All were irradiated; 8 died with carcinoma (the longest survival was thirty-one months), 1 patient, with a 3 cm. diameter submaxillary metastasis and also invasion of the mandible, died of other causes six and one-half years after treatment without recurrence.

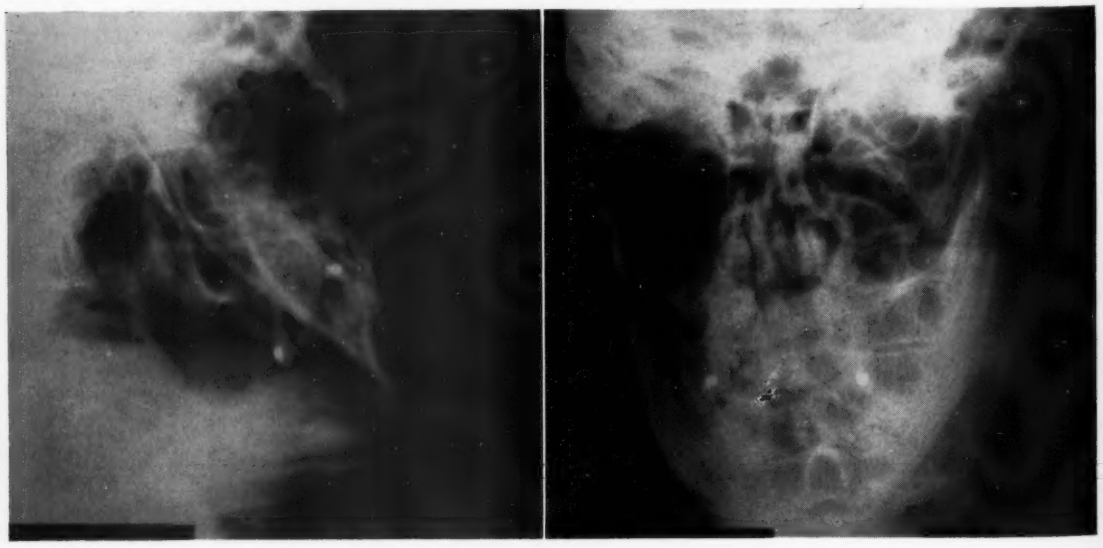

Fig. 8. Roentgenogram of mandible showing bone destruction from a carcinoma of the gingiva in a seventy-seven year old male. The tumor occupied most of the left lower alveolar ridge obliterating the gingivobuccal groove and invading the buccal mucosa and the retromolar area. Treatment was solely by external roentgen irradiation. The patient died five and one-half years later without recurrence. No osseous necrosis developed.

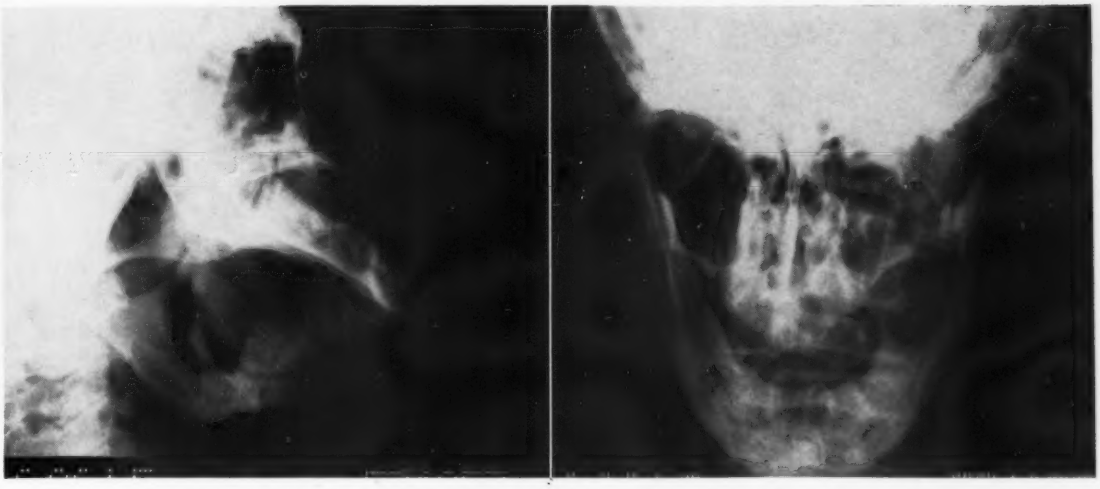

FIG. 9. Roentgenogram of mandible showing bone destruction at junction of horizontal and ascending rami. An ulcerated tumor was present in the left lower molar region extending into the gingivobuccal fornix, the buccal mucosa and the retromolar area. Treatment was solely by external irradiation. The patient is free of neoplasm six and one-half years after treatment and did not develop necrosis of bone.

Three patients developed cervical lymph node metastases within one year after treatment. The metastases were not treated in 1 patient, irradiated in the second, and radically dissected in the third; all died with neoplasm, the longest survival being three years.

Using the same physical factors as for carcinoma of the buccal mucosa, 27 patients were treated with external roentgen irradiation, 5 with peroral irradiation and 7 with a combination of external and peroral treatment. With the exception of the cases treated perorally, the tissue doses are essentially scattered about a straight line connecting 4,500 r in twenty-one days with 6,000 r in forty-five days. The peroral cases average about 6,000 r in twenty-one days.

Of the 39 patients, 27 are eligible for computing a five year survival rate. Eight were alive without neoplasm at five years, giving a five year survival rate of 29.6 per cent. Employing the actuarial method described above on the entire group of 39 cases, an estimated five year survival rate of 33.4 per cent is obtained. Figure 10 shows duration of survival and status of each of the 39 patients.

As with carcinoma of the buccal mucosa, few data are available in the recent literature on results of radiation treatment of carcinoma of the lower gingiva. Often this tumor is grouped with other oral cancers and in many reports both surgical and radiation methods have been used on the primary lesion. A further difficulty is due to the fact that upper and lower gingival carcinomas are usually reported as a single group. In Table II are listed some recent reports, but most of these include upper gingival lesions.

It is commonly stated that carcinoma

TABLE II

CARCINOMA OF LOWER ALVEOLAR MUCOSA REPORTED RESULTS; RADIATION TREATMENT

	No. Patients	Per Cent 5 Year Survival Rate
Paterson *et al.*,[5] 1946	59*	33
Perussia,[7] 1949	50*	46
Ledlie and Harmer,[2] 1950	54	27
Wood and Boag,[9] 1950	27*	30†
Paterson *et al.*,[6] 1950	101*	34
Mattick and Meehan,[4] 1951	101	19

* Includes upper alveolus.
† Calculated by Method of Maximum Likelihood.

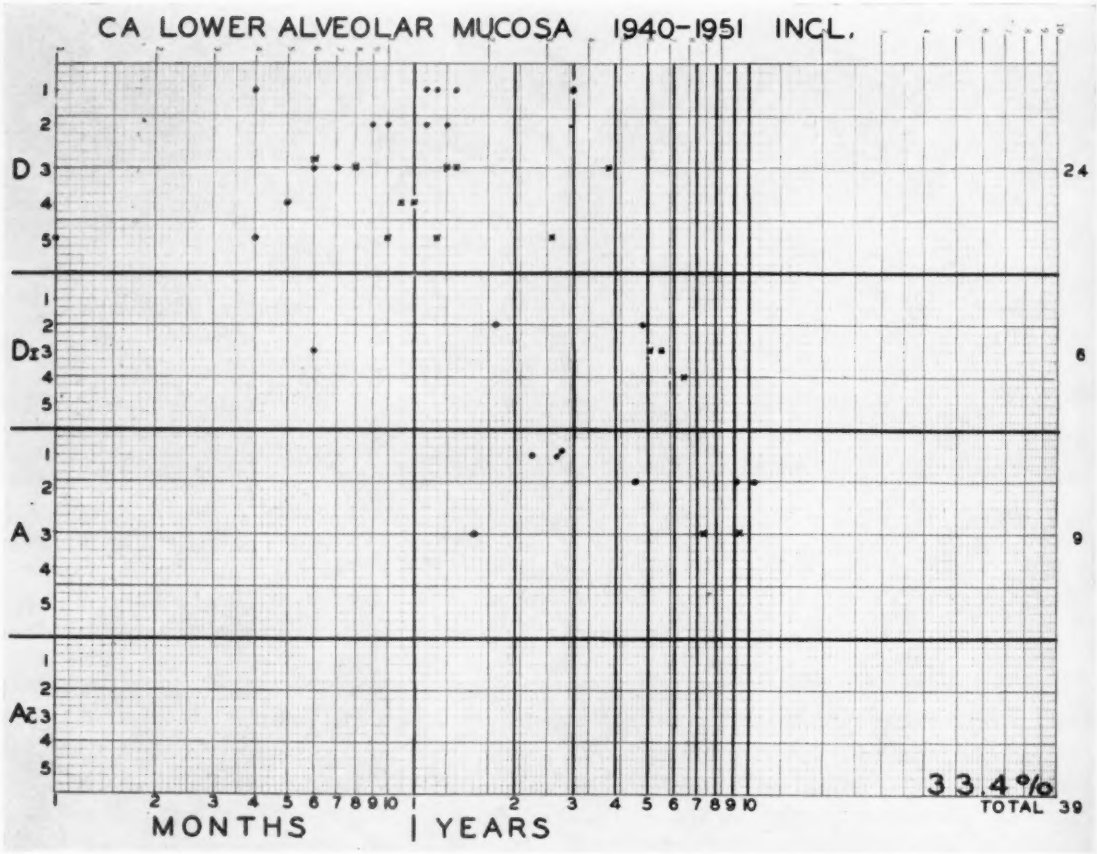

Fig. 10. Dot graph on semi-log paper of survival and status for the 39 cases of carcinoma of the lower gingiva. Each patient is represented by a dot which in relation to the horizontal axis indicates duration of survival after treatment. The dots are divided into 4 groups: *D* indicating the patients dead with neoplasm or with no assurance to the contrary, *D*1 representing patients dying of other causes without evidence of neoplasm, *A* standing for those alive without neoplasm and *Ac* alive with neoplasm.

of the lower gingiva cannot be cured by radiation methods when the mandible is invaded and that radiation osteonecrosis is virtually inevitable. Our experience does not support this view. In 14 patients, there was indisputable roentgenographic evidence of bone destruction. Two examples are shown in Figures 8 and 9. Four (28.6 per cent) of these patients were alive without recurrence at five years after treatment, a survival rate which approaches that for the entire group. Two of the survivors did not develop osteonecrosis. In 1, the patient extruded a number of small bony spicules over a number of years but symptomatic distress was minor. The fourth patient, following external irradiation, showed primary regression of his lesion without osteonecrosis. Ten months later an extension into the floor of the mouth appeared and was treated with insertion of radon seeds. This was followed by soft tissue radionecrosis and eventually necrosis of the mandible. A large sequestrum was removed one year later. The patient is alive without recurrence nine and one-fourth years after initial treatment.

SUMMARY

1. From 1940 to 1951 inclusive, 50 previously untreated carcinomas of the buccal mucosa in all stages of the disease were irradiated. Of 30 eligible for five year survival rate computation, 50 per cent were

alive without neoplasm at five years. For the entire group of 50, an estimated five year survival of 46.4 per cent has been computed.

2. During the same period 39 previously untreated carcinomas of the lower gingiva were irradiated. Of 27 eligible, a five year survival percentage of 29.6 was obtained. For the entire group of 39, the computed estimated five year survival rate was 33.4 per cent. Of 14 cases showing unequivocal bone destruction, 4 (28.6 per cent) were without recurrence at five years.

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DISCUSSION OF SYMPOSIUM ON TREATMENT OF CANCER OF THE ORAL CAVITY*

Dr. Danely P. Slaughter, Chicago, Illinois. I should like to congratulate the other three essayists. Their figures presented today are the best I know of in the literature concerning cure rates in this problem.

Personally, I find cancer in Chicago a very difficult disease to cure, but it points up something worth considering, namely, the difficulty in comparing various series. In my own experience the material at the Research Hospital in Chicago, which is a state charity teaching hospital at the University, is much more advanced than what I see in my own practice, and the results are correspondingly poor.

Dr. Ash is particularly fortunate in his group in having Dr. Harold Wookey working with him, one of the pioneers in the surgical management of this disease, and I think they have an ideal combination and sincere appreciation of the capabilities of either modality of radiation or surgery or combinations of them. As I stated earlier, our only prejudice, of course, should be against the disease, and not against any method of treatment.

These figures, however, are like a lot of other cancer figures. We keep quoting the results of this or that center where special studies and special talent are devoted to the disease, and we think that is what happens to cancer in this country. Gentlemen, it isn't. These 50 and 47 per cent survival rates are superb results, but the over-all salvage of oral cancer, particularly in this country, is probably less than 5 per cent. That is a grim figure, but it happens to be a grim business.

We cannot compare the radiation failure in Research Hospital, which is the waste basket of the whole State of Illinois, with the radiation failure of Dr. Martin of Texas, or Dr. Ash, or the experts like Dr. del Regato, who devote their attention and skill to this disease.

Most patients treated by radiation are not treated with that degree of skill and knowledge; and that, of course, is equally true of surgery, perhaps even more so in this particular field. I think it is fair to state that there are not enough good radiotherapists in this country who devote their time to it, and certainly there are not enough surgeons trained in this field.

Those of us who are working in it must study this and keep it up. We also must teach and bring recognition of the fact that this is a fatal disease and cannot be treated casually, as it is too often. Until we develop 100 per cent cures for cancer, we must consider every patient a problem in clinical investigation.

* Papers by Drs. Danely P. Slaughter; C. L. Ash and O. B. Millar; John Modlin and Richard E. Johnson; and Isadore Lampe.

Dr. Clifford L. Ash, Toronto, Ontario, Canada. I certainly would concur in the remarks by Dr. Slaughter. I think this disease, even in well organized clinics, does not give very good results, and unless we get together and combine our efforts to try to improve results, they may become worse.

Our feeling is that treatment of malignant disease as a whole should be centralized to some extent where all facilities are available for treatment, obtaining of consultations and thus making a combined effort to control it.

There are one or two things that I would like to ask the other speakers. I would like to ask Dr. Slaughter whether he would be interested in preoperative radiation therapy in some of the more extensive lesions, followed by operation later, in the hope that better results might be obtained than with operation alone.

At our school we are very interested in this problem because in breast carcinoma, as in carcinomas of various other sites, our best results are now being obtained by a combination of effort in which irradiation probably limits the field of involvement, and surgery can be carried out with less likelihood of recurrence. I have an idea that in some of the more extensive lesions, at least, this would be helpful.

I have wondered about the multicentric origin of carcinoma. I think there certainly are such cases. We not infrequently see patients with multiple lesions developing in the mouth. I am not sure that all oral lesions are of this nature, for we have those cases as shown (76 per cent of the early lesions of carcinoma of the tongue) being treated successfully by initial therapy and no further lesions developing. Treatment either covered multicentric areas of involvement, or these cases were not of multicentric origin. I do not think that I subscribe completely to the multicentric theory for all lesions.

In Dr. Modlin's paper two questions came to my mind. I was much interested in the proportion of bone involvement in carcinoma of the gingiva and buccal mucosa. Fifty per cent of his cases show bone involvement. I gather that this is by pathological as well as clinical examination. I would be interested in knowing in what percentage of the patients he was able to determine bone involvement before his operative procedure.

The other question I should like to ask Dr. Modlin is this: In his figure he quoted an excellent survival rate of 47 per cent absolute survival. Is this term "absolute" meant to include every patient coming to his clinic with carcinoma of the buccal mucosa and gingiva, whether treated or otherwise, or is there some selection of cases including operative deaths?

Dr. Lampe's paper was very interesting. I think that if on occasion he employed some radium needles, he might be able to save some of his patients who did not respond entirely to high voltage radiation.

In attempting to evaluate our methods of treatment, we found that a combination of radium and external irradiation, or radium alone, seemed to give us a little better result.

Dr. John J. Modlin, Columbia, Missouri. For at least two reasons, Dr. Slaughter and I should avoid at all cost any differences of opinion with the radiotherapists on today's program. The first reason, while perhaps somewhat facetious, is nevertheless important—we are the only two surgeons present in this large audience comprised entirely of radiologists!

Secondly, and more seriously, I happen to have been associated with an institution where a definite radiotherapy service is well established. At the Ellis Fischel Cancer Hospital the treatment of the individual cancer patient is determined following joint examination and consultation by the radiotherapist and surgeon. Approximately 40 per cent of the beds at the hospital are occupied by patients undergoing radiotherapy and these comprise a separate and distinct clinical service under the direction of the radiotherapist. Accordingly, an amiable relationship exists between the surgical and radiotherapeutic services with profit to the surgeon as well as the radiotherapist.

I have heard Dr. Slaughter speak on the subject of oral tumors before and I really can't find much with which to disagree today. I wish to re-emphasize the importance of the concept of the multicentric origin of these tumors. Like Dr. Ash, I do not know the percentage of patients in which multicentric origin can be proven, but a considerable number of patients return to the Ellis Fischel Cancer Hospital with a new lesion at an entirely different primary site within the oral cavity. We, too, have demonstrated multiple foci of origin upon careful histologic examination of large areas of the oral mucosa. We rarely employ the "pull-

through" type of operation in the surgical treatment of oral tumors. The improvement in cure rates following the development of the principle of en bloc resection of the primary cancer and the cervical lymphatics is probably the result of the wide exposure and consequently wider removal of the primary cancer. Cancer surgery requires wide exposure and the removal of a wide margin of normal tissue around the tumor; if the mandible is preserved as in the pull-through procedure, this principle may be compromised. The most radical procedures consistent with a respectable mortality and morbidity are none too radical in dealing with cancers which have heretofore consistently proved fatal in from 70 to 90 per cent of these cases. I believe that a portion of the mandible should be sacrificed without hesitation in the majority of patients treated by the jaw-neck procedure.

Regarding Dr. Ash's question concerning the percentage of bone involvement, roentgenograms of the mandible were obtained in almost all patients prior to operation. Roentgenographic evidence of erosion of bone of the magnitude illustrated by Dr. Lampe is not necessarily synonymous with histologic invasion. We have blocked the entire specimen without finding histologic bone invasion in cases with a preoperative roentgenographic diagnosis of such bone involvement.

In regard to Dr. Ash's question concerning selection of cases in our material, it should be emphasized that there was no selection other than that only primary (previously untreated) cases are included in the group with cancer of of the buccal mucosa and lower gingiva. In the total group of 110 jaw-neck operations performed at the Ellis Fischel Cancer Hospital the figure of 48 per cent absolute survivors in 42 patients capable of a five year follow-up does include 13 cases (37 per cent) with a history of previous unsuccessful treatment by other means.

Dr. Lampe has presented surprisingly good five year survival rates following treatment by irradiation of cancers of the buccal and gingival mucous membrane at the University of Michigan. Knowing Dr. Lampe, I am sure that these results are exceedingly accurate and honestly presented. Many of us, and in particular those interested in the surgical treatment of oral cavity cancer, are inclined to compare our present day surgical results with the results following the irradiation methods used twenty years ago. I find that it is necessary to remember that irradiation techniques have also improved, as has been so well shown today.

Dr. Isadore Lampe, Ann Arbor, Michigan. Being the last speaker on this round, I find everything I wanted to say has already been said. I would like to add a word or two about the indications that Dr. Slaughter mentioned.

I would like to point out that we have irradiated some lesions that we would preferably have seen subjected to radical surgery. Many of the patients whom we took for treatment we would most happily have passed on to others.

Initially, in the period from which our cases are drawn the surgeons were not doing the radical procedure; and although they are doing it to some extent at our institution at the present time, all too often I find cases I would like to see operated on are advanced and they do not wish to accept them. So, we take them and do what we can for them. The results, of course, are quite poor.

In regard to Dr. Ash's remarks, I stand in admiration of the results he obtains in carcinomas of the floor of the mouth. I think they are excellent. Our own level is something like 28 to 29 per cent. Certainly I thank him for his advice about the use of radium needles. They are very interesting. However, in carcinoma of the buccal mucosa I don't think it is necessary to use them because one can get in an adequate dose in the proper time with external and/or peroral irradiation; this is essentially a superficial lesion. I believe that in carcinoma of the lower gingiva radium needle insertion is not a very good method of treatment. I think the focal intense dose around the needle which is imbedded in or close to the bone might present some difficulties. In other fields in the oral cavity I think his point is well taken, and we do know that radium needles exist.

Dr. Slaughter (closing). I agree with Dr. Modlin that he and I came here with some trepidation, but I must mention that my academic title is also in radiology as well as surgery. I think it is simply because Roger Harvey has forgotten about it, or maintained it as a matter of courtesy.

In regard to Dr. Ash's question about preoperative irradiation, I think it is a philosophic concept. I do not recall a patient, who

was inoperable technically, being made operable technically by irradiation, who was cured.

I agree that the inoperable case occasionally can be made to regress to an extent where it is then technicially possible to excise it surgically, but the outlying cancer cells in the periphery of the field that make it inoperable, I suspect, are still there.

I don't like preoperative irradiation, for the same reason that I don't like to operate on radiation-treated patients—patients treated as a curative attempt with failure, because surgery in irradiated tissue is difficult. Healing is bad. In contaminated wounds, infection is worse. I would prefer to leave out the preoperative irradiation for that reason, if for no other.

However, if you are going to give half of a theoretic cancerocidal dose, why do it at all? If you are going to give a concerocidal dose, why operate? That is how I feel about that point.

As to the multicentric question, perhaps I overemphasized that. It is simply one factor in many in recurrence. I do not think for a moment that 100 per cent of oral cancers will have this factor of multicentric origin. I don't know what the percentage is. Constance Wood describes one-third of her failures as being due to it, but I don't know how she arrives at that figure. It is a very definite factor, however, and one to be considered in all the other aspects of attempting to treat this disease.

The pull-through procedure, I agree, is a dangerous one because of the temptation to overextend the limits of its capabilities, whatever they may be. The same thing happened in cancer of the larynx when chordectomy or laryngofissure was started. The results were very poor because the limitations of the procedure were extended constantly. Until that was recognized, the operation fell into disrepute; but when those limits are rigidly defined, the surgeons who do it do get 95 per cent cures. I think the same principle applies here.

I should like to see us stop concentrating on a 30 per cent survival rate, or 40 per cent, and concentrate on our 60 and 70 per cent failures.

Dr. Ash (closing). I think Dr. Slaughter misunderstood my question to some extent. When I said "preoperative irradiation," I was thinking of that as part of the plan of the initial treatment. Preoperative irradiation, if given, should be given to a total cancerocidal dose. I do not believe in half measures.

We have found that if one operates on irradiated tissue within two to three months (my surgical confrères tell me), there is not the same trouble technically and with healing that there is after an interval of six months or a year, when fibrosis has become permanent and the blood supply markedly diminished.

The reason why I raised the question of preoperative irradiation is that we have had a few cases in our group in which the patient has been declared inoperable, with a large mass in the face or the neck, who have been treated, and in whom the mass has either been excised and treated, or treated and excised. Neither irradiation nor surgery alone would have cured the patient, and yet there have been a few cases that have done well with the combined effort. I believe there is a place for a combination of the two procedures.

I would agree with what Dr. Lampe has said regarding needles. We all have our own "pets" and become more familiar with one modality than another. Because a procedure in our hands has not proved to be too successful it does not mean that in the hands of another, more skilled in its application, it may not be equally as good, or even perhaps better.

I agree with Dr. Slaughter. It is what becomes of the patient that is the important thing. So often we are apt to forget all about the patient, and become interested in the technical aspects alone. I think the patient must come first, both from the point of view of saving his life and also restoring him to a useful role in the community. I believe our efforts should always be directed toward that end.

Dr. Lampe (closing). In the 4 cases I discussed I have no histological proof of invasion of bone. In the roentgenograms there were extensive areas of bone destruction. We did not include any cases in which there was some surface erosion on the alveolar ridge, but I cannot say that histologically there was invasion of bone. I thought the presumption would be a pretty good one. That is the only point I have to make.

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RESPONSE TO TOTAL BODY IRRADIATION*

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AS A result of our increased knowledge of radiation biology, it has become necessary to re-evaluate our concepts relative to the limitations of total body exposure to ionizing radiations. The older terminology of "tolerance dose" connoted a minimum dose of radiation which was tolerable to the intact human organism as a unit. Radiation exposures at or below this tolerance level implied that no injury would result. Such a concept further implies the biological reactions within the human body to be reversible and non-accumulative at certain dosage levels.

Our present knowledge of radiation biology, although far from complete, forces us to believe that any amount of radiation energy which is absorbed by the intact living organism *may* result in damage to one or more biological systems although the injury *may* or *may not* be detectable during the lifetime of the individual. In general, any specific biological system is altered in degree in direct proportion to the amount of the particular radiation absorbed. This statement is subject to limitations, depending upon the dose-time relationships, the sensitivity of the specific system, the species under consideration and the type of radiation employed. All types of penetrating radiations produce biological reactions which are qualitatively similar although they may vary quantitatively, depending upon the wavelength of the photons and/or type of radiation employed, *i.e.*, soft roentgen rays, gamma rays, neutrons, alpha particles, etc. The respective radiations also vary in their efficiency in producing a specific biological reaction, depending in part upon the environment and the physicochemical state of the biological system.†

† Temperature, concentration of solute, O_2 saturation.

As experimental data have accumulated it has become evident that at very low dosages of total body irradiation (300 mr per week) the probability of the occurrence of a detectable or undesirable effect resulting to the exposed individual, while remote, is nevertheless statistically possible. At present-day permissible exposure rates it can be predicted (barring accident and gross negligence) that no *acute* manifestations will occur. This same degree of confidence cannot be entertained relative to the possibility of delayed or late effects which may become manifest after a period of twenty to thirty years or perhaps in future generations. Up to a certain point, many of the acute biological changes resulting from irradiation are reversible and, as such, are subject to recovery and repair. The late effects, at least in part, are the result of tissue insults which are non-reversible and accumulative[7] in nature. A radiation genetic change is one example of the non-reversible and accumulative effects.

The term, "maximum permissible dose," came into use within the Medical Projects of the Manhattan District. The radiation physicists, radiation biologists, and medical scientists worked in close cooperation in an attempt to understand the biological actions of radiation and to establish terms which would more accurately express their concepts. These concepts required a new terminology which would take cognizance of the possibility of delayed injuries as a calculated risk. It must be remembered that radiation biology is a rapidly developing field and as our information increases our concepts and terminology undoubtedly will alter.

The term, "maximum permissible dose," indicates the acceptance of the theoretical possibility of injury and defines the limits

* From the Department of Radiology, School of Medicine, University of California at Los Angeles. Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

beyond which the calculated risk may become prohibitive. The ranges of the maximum permissible dose permit consideration of regional versus total body exposure; the relative degree of sensitivity of the respective organs; the duration of exposure; the age of the individual exposed; and whether applicable to civil peace time needs, military and/or disaster planning.

The National Bureau of Standards has published Handbook 59 on "Permissible Dose from External Sources of Ionizing Radiation" which is a comprehensive consideration of the subject. The excellence of the handbook is largely the result of work done by G. Failla. Each radiologist and radiology resident should secure a copy and familiarize himself with its contents.

Present-day concepts of the biological action of penetrating radiations postulate the conversion of radiation energy into chemical energy which, in turn, initiates a sequence of biological responses. When this takes place in warm-blooded mammals a series of events is set in motion which follow one another in rapid successsion.

The first event is concerned with the conversion of quanta of energy to chemical energy by the process of ionization. Mainly on the basis of theoretical considerations, this process in water, which is the most plentiful chemical in biological systems, is visualized as separating the water molecule into the primary active radicals, H and OH. These primary radicals are short lived and probably do not stray far afield from their point of origin. Further theoretical considerations permit the visualization of the formation of H_2O by interaction and/or a regrouping with O_2 to form potent oxidizing secondary radicals such as H_2O_2 and HO_2.[10] The first H_2O_2 is an actuality and can be measured following the irradiation of water in vitro.[8] The presence of O_2 should greatly increase the molecular yield of these secondary radicals. It is possible or even probable that these highly oxidizing radicals may directly attack cellular membranes, enzyme systems, genes, chromosomes, or other protoplasmic constituents. It is equally possible and more likely that these primary and secondary radicals alter certain intercellular and intracellular components so as to destroy certain essential chemical substances and/or to form new chemical compounds which, in turn, act as protoplasmic toxins.

In this latter respect biologists have found it difficult to explain adequately the discrepancy existing between the high radiation doses required to produce the extremely small molecular yields in in vitro radiation chemistry, and the low radiation dose required to bring about major biological results in intact mammals. The work of Dale[14] with solutes in low concentrations was the first important contribution offered as a partial explanation. Additional contributions have been made by Baron *et al.*[3] on the sensitivity of the SH groups, on the competitive (protective) action of albumin by Evans *et al.*,[17] and on the addition of compounds containing SH groups such as cysteine by Patt *et al.*[40] However, these factors seem inadequate in themselves to fully explain this discrepancy. It has been necessary to postulate additional contributing factors such as: (1) the presence of a major back reaction in in vitro studies which is not operative or operative to a lesser extent in in vivo studies; (2) the formation of active secondary or tertiary radicals having a longer life span and a greater range of diffusion than those previously postulated, or (3) the initiation of a chain reaction in vivo which results in a molecular yield far in excess of those already postulated and discussed.

The reaction recently described by Mead[34] may further add to our knowledge of fundamental radiation chemistry in this respect. He has found that roentgen irradiation of essential fatty acids or dilute aqueous suspensions of their methyl esters initiates a chain reaction resulting in the production of free radicals containing conjugated double-bond systems, and in the accumulation of peroxides. Very high yields of these substances may be obtained

under proper circumstances. Other materials, such as vitamin A, when present as the sole solute are rapidly destroyed when irradiated in solutions or emulsions of an essential fatty acid. Of added interest is the fact that these reactions in vitro may persist up to one hour after irradiation. The addition of cysteine reduces the yield. A state of partial O_2 depletion also results in a very marked reduction in yield.

Regardless of the exact nature of the chemical processes involved, the various steps enumerated follow in rapid sequence and, in general, are of short duration. If a chain reaction involving essential fatty acids takes place in vivo as it does in vitro, it is possible for the process to continue for perhaps an hour. Evidence for such a process has been demonstrated in postirradiated mice by Horgan and Philpot.[23] Toxic by-products such as organic peroxides and/or other toxins, if present, may be active over a prolonged period, depending upon their stability, concentrations, and the detoxification processes available to the body. In general, the major biological responses resulting therefrom become manifest over variable latency periods.

The total body response to irradiation is a manifestation of chemical, cellular, and tissue alterations, providing the sum total of these specific and individual alterations is of sufficient magnitude to be reflected in the clinical behavior of the animal. The type of the response, its time of occurrence, its duration and degree depend upon the species of animal involved, the size of the dose of radiation given, the associated modifying circumstances, and the duration of the observation period.

Under standard conditions, it is possible to deliver to warm-blooded mammals graded doses* of total body irradiation which will bring into evidence biological reactions from those of the lowest order of resistance upward one by one in an accumulative fashion until the sum total of these responses results in the ultimate death of the organism as a whole. The doses required to bring about subclinical effects may vary from a few roentgens to hundreds of roentgens. The lowest dose required to produce an effect is theoretically one photon. This amount could produce a gene mutation; 5 to 25 r will produce temporary cessation of mitosis[29] and a reduction in circulating lymphocytes.[31] Statistically it can be shown that 0.5 r total body roentgen irradiation to dogs six days per week for two years will result in a reduction in the circulating lymphocytes.[24] Dosages in amounts of 50 to 100 r will bring about chromosomal abnormalities and a temporary increase followed by a reduction of granulocytes. Up to this point, little total body response has occurred which is observable by routine clinical methods. With doses of 100 to 200 r, most mammals reveal detectable responses such as anorexia, nausea, and weight loss. When dosages above 200 r are administered, more profound reactions are manifest such as shock and prostration, which may be followed in some species within a few days or weeks by hemorrhage and death.

Not all the responses enumerated are observed in each species of mammal, nor in each animal of a given species. Most of these manifestations occur within the first thirty days and may be considered the acute or prompt responses, as contrasted with the delayed or late effects to be described in the latter part of our discussion. In either instance, if the dose of radiation is sufficient, death of the animal is the concluding manifestation.

The most common prompt responses of mammals to acute total body irradiation at or near the thirty day LD50 are as follows:

1. Immediate reduction (within hours) of circulating lymphocytes.
2. Immediate rise of granulocytes (12–18 hours) followed by a prompt fall.
3. Reduction of platelets beginning in the first 24–48 hours.

* Each individual total body dose delivered over a continuous period of time not to exceed a few hours, as contrasted with prolonged (24 hour) or chronic irradiation over months or years.

4. Loss of appetite
5. Loss of weight
6. Inactivity

(beginning during the first week)

7. Hemoconcentrations, first 3 days.
8. Precipitous fall in red blood cells and hemoglobin, 7–15 days, but may occur later.
9. Diarrhea, watery changing to bloody, 4–15 days.
10. Emaciation, noticeable at end of first week.
11. Evidence of prostration, sepsis, and fever, second and third weeks.
12. Death, most frequent 7–20 days. (It should be noted that increasing dosages hasten mortality. If dosage is sufficiently high a 100 per cent mortality may be produced within as little as 5 days.)

In those animals dying within the first thirty days following irradiation the most common postmortem findings are:

1. Gross hemorrhage.
2. Sepsis.
3. Ulceration of the small intestine.
4. Splenic atrophy.
5. Bone marrow depletion (from aplastic to various degrees of regeneration, depending on the day of death).

The animals surviving the thirty day postirradiation period, with but few exceptions, regain for a time an apparently normal state of growth and activity. Their late manifestations will be discussed in detail under "delayed response."

The prompt total body response to radiation delivered in or near the thirty day LD50 range may be greatly modified by preirradiation medication with cysteine[40] or glutathione[38] to the extent that the LD50 dose may be increased by 100 per cent. The explanation appears to be that the SH groups contained in cysteine and glutathione compete with the active radicals formed by ionization to spare destruction of SH-containing compounds within the body. This is a competitive or neutralizing process. This type of medication is not effective if given postirradiation.

Similar results, although of only temporary nature, may be obtained in frogs and tadpoles if they are irradiated while at low temperatures and maintained post irradiation at this low temperature.[1,39] If, however, the specimens are subsequently returned to room temperature, the biological responses are observed to occur at the rate and frequency with which they would have occurred had irradiation been carried out under standard conditions. Here, the biological changes are merely slowed and/or temporarily interrupted by virtue of a greatly reduced metabolic rate. It seems reasonable to assume that, as a result of ionization, the primary and secondary radicals are formed at the time of irradiation under the modified temperature conditions, and that the chemical, cellular, and tissue changes and/or damage are initiated, but completion of these reactions and progression to gross changes are markedly slowed or delayed as a result of the reduced metabolic turnover.

Further studies have been conducted by Haley *et al.*[20] on the effect of the metabolic rate on the total body response to radiation. Corresponding groups of rats were employed in a series of experiments. One group was thyroidectomized, one group was premedicated with thiouracil compounds, and a third group was pretreated with thyroxine to the point of toxicity. There was no appreciable difference in mortality in the first two groups when compared with a control group similarly roentgen irradiated. The thyroxine-medicated group revealed an increased rate of mortality when compared to the controls. Stress in the form of exertion has been found to both accelerate and increase the percentage mortality of postirradiated rats.[28]

Rats irradiated near the LD50 range in an anoxic state[16] (5 per cent oxygen and 95 per cent nitrogen atmosphere) and immediately returned to normal atmospheric conditions following irradiation reveal little, if any, of the clinical manifestations of total body radiation within a thirty day period. One observes a very slight weight drop for one to three days, but on clinical

inspection these rats cannnot be detected from non-irradiated ones of the same age. The peripheral blood changes are found to be comparable to those in rats irradiated under standard atmospheric oxygen with one-half the dose of radiation.[5]

When rats are pretreated with NaCN to "tie up" the respiratory enzymes, no such protection has been observed by us in our laboratory.[16] Rats premedicated in this fashion and subjected to 800 r total body radiation suffered 100 per cent mortality in eleven days. A similar group irradiated at 800 r at the same time, but not premedicated with NaCN, suffered 100 per cent mortality in nine days. These findings are not in accord with the results reported by Bacq and Herve.[2]

Available evidence points to the fact that there is a decided difference between tissue anoxia (oxygen lack) and oxygen utilization. In the absence of oxygen, certain secondary active radicals are either not formed or are formed at a greatly reduced rate and in smaller quantities. This thesis is supported by theoretical considerations, by in vitro experiments, and by other anoxic biological experiments. The low temperature studies with frogs and tadpoles indicate that the low metabolic rate (low O_2 utilization) postpones but does not prevent the occurrence of the biological responses.

Several methods are now available which, when applied following irradiation, modify the total body response to acute radiation. Jacobson *et al.*[25] have demonstrated that, in mice, splenic shielding at the time of irradiation or splenic transplants into the peritoneal cavity postirradiation greatly modify acute responses and reduce mortality. Lorenz *et al.*[32] have accomplished similar results by postirradiation intravenous or intraperitoneal injections of bone marrow suspensions in mice and guinea pigs.

Utilizing massive cross transfusions in dogs, Salisbury and associates[41] were able to modify the peripheral blood picture Brecher and Cronkite[9] suggest that postirradiation parabiosis in rats accelerates recovery of myelopoiesis by the transfer of some cellular or non-cellular material from the nonirradiated partner.

Hemorrhage is one of the most important major clinical manifestations taking place in rats, dogs, and man following lethal exposures to total body radiation. In extreme instances, it occurs into the skin, into the subcutaneous areas from the mucous membranes and especially into the pulmonary tissue, and from the gastrointestinal tract. Our knowledge of the pathogenesis of the hemorrhagic syndrome is far from complete, but there is a growing literature which is constantly adding to our fund of information.

Speculation has arisen as to the integrity of the capillary walls in the hemorrhagic syndrome following fatal doses of radiation. Is there an increased fragility so that frank rupture of the capillaries would occur with slight trauma, or is there some alteration of the intercellular interstices permitting an increased permeability to the blood? Mice subjected to an approximate LD50 dose of roentgen rays and subsequently exposed to blast pressures of varying P. Si. at various intervals following irradiation revealed no noticeable increase or alteration of bleeding tendencies when compared with a control group of mice similarly irradiated, but not subjected to the blast.[12] These experiments, though not conclusive, tend to mitigate the theory of an increased tendency for the capillaries to be more susceptible to frank rupture following irradiation. Kahn and Furth[26] have demonstrated in dogs and rats that irradiation at or below the median lethal dose results in the escape of red blood cells from the capillaries into the tissue spaces and lymphatics by virtue of capillary endothelial damage.

Haley *et al.*[21] have demonstrated in rats a decreased sensitivity of the precapillary sphincters to epinephrine. This has been traced to the presence of circulating ferritin in the blood three to four days after irradiation.

The hemorrhagic syndrome may be completely prevented in rats irradiated in the anoxic state until the dosages reach magnitudes betweeen 1,200 and 1,400 r, when it occurs with the frequency and to the extent found in rats irradiated in normal atmospheric conditions at doses of 600 r.[16] Similar protection is obtained by pre-treatment with cysteine.[37] It is of interest to note that in our experiments anoxic rats may be subjected to 1,000 r with maximum depression of the peripheral leukocytes and platelets without the concomitant massive hemorrhagic state. Cronkite and associates[13] have demonstrated that daily platelet transfusions in the postirradiated dog restore clot retraction and modify the hemorrhagic tendency.

The anemias which occur in animals following total body irradiation are extremely difficult to evaluate, especially in those animals showing no frank hemorrhagic tendencies. In instances associated with frank hemorrhage there is no need for further comment. The slight increase in the red blood cells and hemoglobin coming in the first few days following irradiation may be attributed to hemoconcentrations from voluntary restriction of food and water by the animals. In rats receiving 500 r total body irradiation there is a precipitous fall in the red blood cell count and hemoglobin values on or near the fourth or fifth day after irradiation.[31]

Several experimenters have reported increased excretion of bile pigments and suggested the following as possible sources: (1) absorption from areas of hemorrhage, (2) destruction of circulating red blood cells, despite the fact that no morphological alterations were noted in smears and mature red blood cells had normal susceptibility to both osmotic and mechanical lysis; (3) destruction of partly hemoglobinized normoblasts in the bone marrow; (4) heme precursors; or (5) breakdown of myoglobin.[15,30,42]

Utilizing tagged red blood cells, Kahn and Furth found no difference in their disappearance from the general circulation regardless of whether they were given to the animal before or after irradiation. From this they concluded that in the dosages employed there was no direct effect of irradiation upon the circulating red blood cells per se.

Bennett and associates,[6] in a study of 54 dogs, attempted an analysis of the anemias occurring in the first eighteen days following heavy irradiation. They indicated that the loss of red blood cells may be due to multiple factors, such as: (1) 16 per cent attributable to blocked red blood cell production; (2) 3 per cent explainable by loss resulting from blood sampling; (3) 7 per cent explainable by hemolysis presumably by direct action of the irradiation on the red blood cells as indicated by urobilinogen. Deferring to the observations of Kahn and Furth, previously referred to, it appears that this 7 per cent loss is more likely the result of destroyed red blood cells extravasated into the tissue spaces and lymphatics than a direct hemolytic action of the radiation.

The anemia presumably resulting from these three factors accounts for 26 per cent of the blood loss and could conceivably account for the anemia of 22 surviving dogs. In 5 dogs dying without evidence of infection the anemia exceeded that found in the survivals by 1 per cent. In 17 dogs dying with positive evidence of infection, the anemia exceeded that found in the survivals by 13 per cent. Five of these 17 dogs had red blood cells and hemoglobin values of only 30 to 40 per cent of their pre-irradiation values. The authors felt it reasonable to assume that infections with hemolytic organisms could play a major role in the added red blood cell destruction and/or increased hemorrhage following the vascular effects of bacterial invasions. The effect of aureomycin alone or in conjunction with streptomycin in dogs would tend to substantiate this thesis.[19]

The role of infection in total body response to irradiation is one of importance. Is it a primary contributor to the radiation

syndrome or is it a secondary factor which appears as a final assault on an already harassed and overburdened organism? Regardless of the answer to this question, its appearance is of serious import. Animals succumbing to irradiation in the first three to four days may not show positive blood cultures, and in such instances infection may be considered as noncontributory. Such early deaths are usually the result of extremely high doses of radiation or represent instances of unusual individual susceptibility to radiation. Animals dying after the first one and one-half to two weeks show an increasing percentage of positive cultures. The presence of infection in these animals can hardly be disregarded as a detrimental factor in their survival.

Significant studies have been made by Vincent and Veomett[43] on the flora of the small intestine in normal and irradiated rats. They have found in the normal small intestine predominantly a gram negative, highly pleomorphic organism, probably related to the lactobacillus. It occurs in greatest numbers in the superficial mucosal layers but is present also in appreciable numbers in the subepithelial layers.

Subsequent to total body irradiation there is a reversal of the normal bacterial flora of the small intestine, occurring between three to seven days after irradiation. At this time there is a marked increase in the coliform, pseudomonas, and proteus species. Restoration of the normal flora, predominantly pleomorphic bacilli, occurs between ten to fourteen days after irradiation. The invasion of the small intestine and the concomitant bacteremia parallel the period of abnormal flora and coincide with the marked postirradiation symptoms in rats receiving 650 r total body irradiation with roentgen rays. Those rats with the most pronounced symptoms reveal small intestinal flora practically devoid of the pleomorphic bacilli, often with a thousand-fold increase in pseudomonas organisms. Bacteremia between six to seven days following irradiation revealed pseudomonas present in numbers as high as 0.2×10^3 to 500×10^3 organisms per gram of tissue.* Miller and Hammond[35,36] consider septicemia by micro-organisms of enteric origin to be one of the main causes of death in postirradiated mice, and have decreased mortality by the use of antibiotics.

Death during the first week after irradiation occurs most frequently in those animals receiving excessively high doses or in individuals unusually susceptible to radiation. The actual causes of death may be shock and/or excessive tissue destruction with marked chemical disturbance. Deaths occurring after the first week may evoke entirely different mechanisms.

It is doubtful if simple depletion of the bone marrow elements per se with its concomitant pancytopenia can be the sole explanation of death. Many animals dying during this period have bone marrows in various stages of recovery. Furthermore, rats irradiated in the anoxic state with doses of 1,000 to 1,200 r develop maximal pancytopenia with 90 to 80 per cent thirty day recoveries, respectively. In those instances of death after the first week, septicemia and extensive hemorrhages appear to be the most common and perhaps the most potent factors. It has been found that during this period physical exertion both hastens the time of death and increases the percentage mortality.

Various methods of increasing the thirty day survival have been discussed. These methods have permitted sufficient survivals, especially among rats irradiated in the anoxic state with conventional LD_{50} and high doses of roentgen radiation, for long term observations of three years and more.

It is our impression from these observations that while anoxia greatly modifies the acute phase of the radiation syndrome it alters little, if any, the delayed or long term effects. Our studies further appear to offer evidence that different mechanisms are operative during these two phases.

Bennett and his co-workers[4] have ob-

* Spleen, liver, and kidney.

served colonies of rats surviving conventional roentgen irradiation in doses of 500 r and similar groups irradiated in the anoxic state with doses of 600 to 1,400 r for periods up to and over 500 days. In all groups there is a marked shortening of the life span proportional to the dose. In general, late effects may be grouped as follows: (1) lowered resistance to infection; (2) aging factors; (3) malignant changes, and (4) anemia. The following is a partial list of the observations which may be made:

1. Marked reduction of life span.
2. A high percentage of deaths due to infection.
3. Cataracts.
4. A generalized alteration of the media of the arterioles.
5. Brown granular kidneys with nephrosclerosis.
6. Arterial hypertension.
7. Cardiac hypertrophy.
8. Cerebral hemorrhage.
9. General cachexia.
10. Late epilations over head and neck.
11. Malignancy.
12. Splenomegaly.
13. Marked anemia.
14. Reticulocytosis.
15. Thrombocytopenia.
16. Hyperplastic bone marrow.

Numerous investigators have reported some of these late changes following acute and chronic radiation in man and laboratory animals. Martland[33] has reported on anemia and osteogenic sarcomas in radium dial painters; Carman and Miller[11] have pointed to the increased percentage of leukemia in radiologists as compared to physicians and the population at large. Folley, Borges and Yamawaki[18] have noted an increase in the leukemias in Japan in areas subjected to the atom bomb. Hartman, Bolliger and Doub[22] have noted acute and chronic nephritic changes in dogs subjected to acute irradiation to the kidney areas. Radiation cataracts in both man and animals are indisputable.

The mechanism whereby these delayed physiological and pathological alterations are brought about in the postirradiated animal are not well understood. Kaplan and Brown[27] have demonstrated that there is a marked difference in the incidence of lymphoid tumors in postirradiated mice, depending upon whether the irradiation is partial or whole body. They found local irradiation to one-half the body is ineffective in the production of such tumors and postulate that in part an indirect systemic mechanism must be operative.

SUMMARY

The total body responses to irradiation are complex and vary in type, degree, and extent with the amount of radiation, the presence or absence of modifying factors, the duration of the observation period (prompt or delayed responses), and the species of animals involved.

Animals succumbing in the first three to five days following acute total body irradiation usually do so as a result of extremely high dosages or unusual individual susceptibility. Little is known about the mechanism of death in such instances.

The main contributing factors in the deaths occurring after the first weeks following irradiation are hemorrhage and sepsis. The mechanism of hemorrhage and the origin and modes of infections are not completely understood, although very definite progress in this respect is being made by various laboratories throughout the country.

Numerous modalities are at hand whereby prophylactic measures may be employed to prevent or circumvent many of the prompt total body responses. Therapeutic measures applicable in the postirradiation period have been more difficult to evaluate and are slower in development. Distinct progress is being made and at least partial success seems likely.

The delayed total body response is less well understood than are the prompt responses. It seems probable that entirely different mechanisms are involved. To date, there are no reports available indicating means whereby these delayed responses may be modified or greatly reduced

in their frequency of occurrence. Since personnel in departments of radiology are unlikely to receive sufficient radiation to produce acute radiation signs and symptoms, our primary concern is in the possible exposure to amounts in excess of the maximum permissible exposure over long periods of time. It is the purpose of this symposium to describe simple and reliable means which are adequate to prevent any significant damage from chronic or delayed reactions to ionizing radiation. Our best assurance is the avoidance of undue exposure.*

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RADIATION PROTECTION PROBLEMS IN DIAGNOSTIC ROENTGENOLOGY*

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THE dangers of small doses of radiation to roentgenologists and their associates have received serious consideration for a number of years. The International Commission on Radiological Protection,[12] after weighing all available evidence, has concluded that a maximum dosage of 300 milliroentgens per week of whole body radiation throughout the individual's adult life will produce no detectable effects and will therefore be safe. For exposure to the hands and forearms only, the safe dosage is 5 times the whole body value. There are some investigators who feel, largely because of genetic effects, that the value arrived at for whole body radiation is too high. The roentgenologist should be alert to the possibility of remote effects from radiation injuries and should always try to reduce to a minimum the amount of radiation to which he subjects himself, as well as his patients. The exposure to the patient due to roentgen-ray examinations has been investigated in the past largely from the point of view of finding out what intensities and doses were involved in these examinations. The emphasis used to be almost entirely on acute effects producing epilation or erythema. Due to a better understanding of the problem, and particularly to increased efficiency of roentgen-ray equipment, acute effects occur now only as a result of carelessness, or of ignorance on the part of untrained personnel. Roentgen examinations of the general population are becoming ever more common and ionizing radiations are used more and more in industry so it is important to know how much radiation energy is being absorbed by these people and how much they can take without subsequent detectable damage. Until we know the answers to these problems it is the duty of the roentgenologist to expose the patient, and himself, to as little radiation as is practicable. This may be done in the roentgen-ray diagnostic department by investigating the sources and magnitudes of direct, and of stray and scattered radiation, and by finding out how these are affected by altering various technical factors. Existing techniques and protective measures may be evaluated and changes made if advantageous.

Roentgenologists and technicians often ask questions such as these: "How much radiation am I getting from this examination?" or "From which of our various diagnostic procedures do we get the most exposure?" "How much radiation does the patient get?" Surveys to find answers to these questions have been made by numerous investigators.[4,5,7,8,9,13,14] In using this information it must be realized (as is often pointed out by the investigators) that the data apply only in the departments and under the working conditions in which the measurements were made. For example, some values of patient skin and depth doses found in roentgenographic examinations under average conditions using 36 inch target-film distance and 1 mm. aluminum filter taken from the paper by Ritter *et al.*,[13] will give an idea of the magnitudes of radiation received by these patients (Table 1).

The skin doses for most of these examinations seem very large when compared with the maximum permissible dose of 300 mr (0.3 r) per week. The latter value was established for whole body radiation, week after week, and does not apply to examinations of patients. In considering the patient, our judgment must take into account the need and value of the examination. If the examination should be a crucial one, the

* From the Department of Medical Physics, Temple University School of Medicine, Philadelphia, Pennsylvania. Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29-Oct. 2, 1953.

Table I*

Part Examined and Projection	Kv. (peak)	Skin Dose (roentgens)	Depth Dose and Depth of Part
Head, lateral	60	2.8	0.5 r at 8 cm., pituitary
Head, anteroposterior	69	5.4	0.9 r at 9 cm., pituitary
Dorsal spine, anteroposterior	58	4.5	
Lumbar spine, anteroposterior	58	4.7	
Lumbar spine, lateral	70	13.5	
Pelvis, anteroposterior	58	5.3	0.6 r at 10 cm., ovary
Pelvis, lateral sacrum	74	21.0	2.8 r at 10 cm., ovary
Chest, posteroanterior, no Bucky	59	.06	
Chest, posteroanterior, with Bucky	77	.43	
Pelvimetry	78	26.7	3.5 r at 11 cm. to ovaries
Pelvimetry	78	26.7	1.3 r at 16 cm. to fetus
Dental, upper molar	65	14.0	

* Data from Ritter, *et al.*[13]

roentgenologist is justified in risking very large doses. On the other hand, the doses the gonads receive in some of these examinations may be noted with considerable concern. In view of recent studies on genetic effects produced by roentgen rays, it is particularly advisable to protect the patient's gonads in both men and women, whenever possible, during diagnostic procedures. Considering the rapid growth of cells and the differentiation taking place in the fetus, it would seem wise to do a roentgen pelvimetry only when essential, and in other ways to protect the fetus from radiation. In roentgen pelvimetry the whole body of the fetus is apt to be irradiated. Cones should be used on the tube housing to limit the roentgen-ray beams to the areas under investigation.

In roentgenoscopy the potentialities of damage both to the patient and to the roentgenoscopist are great. This is because roentgen-ray intensities may be high, the roentgen field may be large, the examiner may put his hand in the direct roentgen-ray beam, and the time of the examination is not limited. The roentgen-ray intensity at the surface of the table on a poor fluoroscope may be 30 r per minute or more. Such a high intensity at the skin of the patient usually occurs because the roentgen tube is too close to the table top, no filter is used, and the fluoroscopic screen may be an old type which is less efficient than modern screens. It is easy to show[3] that when the tube-to-table-top distance is increased, for a given brightness of the screen, the dose to the patient is decreased. The addition of 1 mm., or better 2 mm., of aluminum filter to the roentgen-ray beam will have a similar effect. With the roentgen tube 18 inches below the table top, a 2 mm. aluminum filter and a Patterson Type B2 screen at 85 kv. (peak), 10 r per minute at the table top should provide sufficient visibility for most examinations. By keeping the field small and reducing the time of the examination as much as possible, both the patient and the examiner will be protected to a large degree. The roentgenoscopist should not put his hands in the direct beam unless they are protected by adequate leaded gloves. He must protect his body and hands from scattered roentgen rays from the patient. This can be done by wearing a leaded apron. Further protection may be provided by hanging a lead-rubber apron from the screen to intercept the roentgen rays from the patient. The roentgen-ray beam should be centered on the screen and the shutter system should be fixed so that it cannot be opened beyond a point which allows the roentgen-ray beam to come within about ½ inch from the edge of the screen. The roentgen tube housing may allow some of the direct roentgen

rays to pass through so the protection problem is not confined to scattered radiation. The new roentgenoscopic image amplifiers will reduce the dose to the patient and to the roentgenologist.

Protection problems arise when a roentgenoscope is used for guidance in orthopedic work. In hip nailing, for instance, the orthopedist's hands are close to the roentgen-ray beam and at times may even get in it. Assistants are close by so that the intensity of scattered radiation may be high. The most practical way to obtain protection is to move away from the irradiated field when the roentgen rays are turned on, to use a filter in the roentgen-ray beam (1 or 2 mm. of aluminum), use adequate kilovoltage and low milliamperage, use a small size field, keep the roentgen-ray beam on only when necessary, and teach everyone involved to respect the danger of the radiation. Leaded aprons will protect the body against scattered radiation.

Special procedures, such as cerebral angiography, angiocardiography and cardiac catheterization, present hazards which can be minimized with a little care. In cerebral angiography the greatest danger is to the neurosurgeon doing the opaque medium injection. If the roentgen-ray beam is properly coned down and aligned in respect to the patient, and a lead-rubber sheet equivalent to 1 mm. of lead is hung between the patient's head and the neurosurgeon, adequate protection may be obtained. Care must be exercised to see that assistants are out of the roentgen-ray beam and away from the head of the patient. The same precautions apply to angiocardiography except that the lead-rubber sheet with a cutout for the arm is hung between the patient's chest and the individual doing the injection. In cardiac catheterization more people are apt to be present on the team. The operator who inserts the catheter and injects the opaque substance is likely to get the most radiation. A lead-rubber sheet will help to protect him. The anesthetist and nurse could likewise be protected but usually this is not necessary. In all of these procedures the only way to know whether or not the individuals are safe is to measure the radiation received by them under actual conditions of operation. In fact, continuous monitoring of those procedures known to require special precautions is of great value and the best way to locate those breaks in technique which might result in serious over exposure to personnel.

Photofluorographic procedures present protection problems because the roentgen-ray field is quite large, the exposure is about twice that required for conventional chest films and the equipment is frequently housed in a limited space, requiring the technician to be fairly close to the tube and the patient. Measurements show that a filter in the roentgen-ray beam will protect both the patient and the technician, and that a 2 mm. lead protective barrier extending well around and over the control stand will give adequate protection to the technician even for a heavy patient load. As in other roentgenographic rooms, care must be taken to shield adjacent rooms, which might be occupied, from direct and scattered roentgen rays.

So far, we have considered some of the problems in diagnostic roentgenology and the methods which might be used to solve them. It may be interesting at this point to study the relationships which hold between quality of roentgen-ray beam, penetration of the patient by the beam, amount of scattered radiation and integral doses to both patient and roentgenologist and his associates. Data for these studies were obtained by making measurements on a full-wave rectified roentgenographic machine with rotating anode tube. The machine had been carefully calibrated for kilovoltage and a presdwood phantom 25 cm. thick was used. The target-to-film distance was set at 40 inches. The chamber measuring the direct beam was placed on the upper surface of the phantom 27¾ inches from the focal spot, and the chamber measuring the scatter was at the level of the center of the phantom and 24 inches from the central

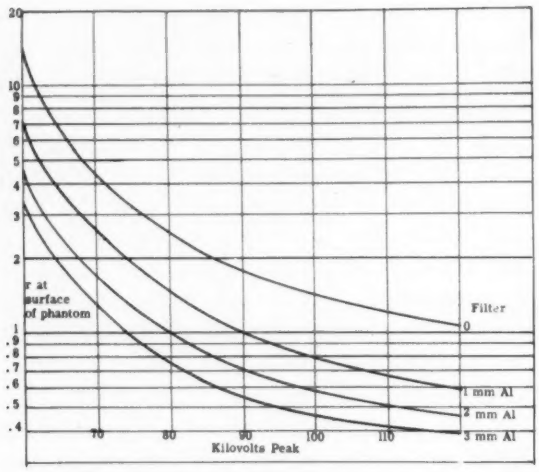

Fig. 1. Roentgens (with backscatter) at the surface of the phantom to give equal film densities through a 25 cm. thick presdwood phantom (with Potter-Bucky diaphragm) for various kilovoltages and filtrations, 25 cm. diameter roentgen-ray field.

ray. A 60 to 100 kv. (peak) range was used and filters up to 3 mm. of aluminum. Table II shows the half-value layers under the conditions studied. The milliampere seconds were adjusted so as to give equal film densities for all exposures.* The roentgen-ray field at the surface of the phantom was a circular area 25 cm. in diameter. Its center was 15 cm. from the edge of the phantom.

The exposures at the surface of the phantom to give equal film density for various kilovoltages and filtrations are shown in Figure 1. The curves indicate that the surface exposure decreases both as the kilovoltage is increased and as the filter is increased. Thus, the least surface exposure is obtained with the highest kilovoltage and the thickest filter. But what about the dosage to the patient throughout the tissues irradiated? To evaluate this, "integral dose" may be used. Mayneord[10] has defined integral dose as the "energy conversion when a dose of one roentgen is delivered to one gram of air." One gram of air and one gram of soft tissue will absorb so nearly the same amount of energy when exposed to one roentgen that the difference may be neglected for comparative clinical purposes. The unit of integral dose is the "gram-roentgen." For clinical use a larger unit, the megagram-roentgen (one million gram roentgens) is more convenient.[11] It represents the total absorption throughout a given mass of tissue and may be expected to run parallel with the biological effect on the patient.[6] The change in integral dose to the patient under the various conditions shown in Figure 1 can be anticipated without going into the formula for integral dose. This can be done by remembering that *the exit dose is approximately the same* for all the curves. (Exit doses for the higher kilovoltages and filtrations are a little less because the screen film combination is more sensitive to the harder radiation. This effect only enhances the results of the conclusions.) As the kilovoltage and the filtration are increased the dose at the top or tube surface of the patient is decreased—according to the curves—and therefore the dose at every level within the patient, from the top surface down, is decreased. Thus the integral dose will be decreased. This is in line with the results found by other investigators.[1,2] Substitution of values in the formula indicates that the integral dose to the patient, using a 1 mm. aluminum filter, will be approximately 1.4 times as great at 80 kv. (peak) and 5.1 times as great at 60 kv. (peak) as it would be at 100 kv. (peak), for the same film density. Increasing kilovoltage and filtration thus protects the patient. But what about scattering to the technician, or to the roentgenoscopist?

Table II

Filter	Kilovolts (peak)				
	60	70	80	90	100
	Half-value layer—mm. Al				
None	0.95	1.05	1.10	1.20	1.30
1 mm. Al	1.56	1.75	1.90	2.14	2.40
2 mm. Al	1.75	2.0	2.35	2.75	3.3
3 mm. Al	1.9	2.5	3.0	3.5	4.0

* I am indebted to Mr. Dewey P. Blackstone, R. T., for computing the correct exposures and for operating the machine.

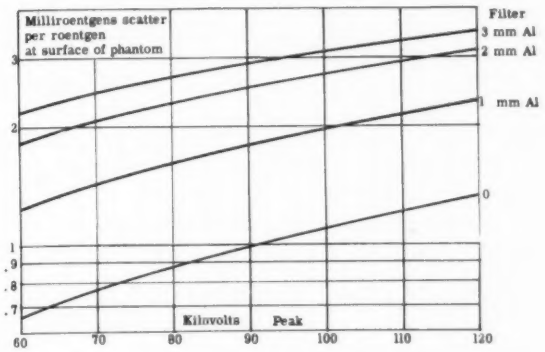

FIG. 2. Scattered roentgen rays (in milliroentgens) at a point 24 inches from the center of the presdwood phantom per roentgen at the surface of the phantom, for various kilovoltages and filtrations, 25 cm. diameter roentgen-ray field.

To show the effect of change in kilovoltage and of filtration on the scattered roentgen rays at a given point, the phantom measurements were plotted as in Figure 2. In this plot the scattering is shown for each roentgen incident in the surface of the phantom. The curves indicate the well known facts that scattering from a given irradiated body (for the qualities of radiation shown) goes up as the kilovoltage is raised and as the filtration is increased. However, for roentgenographic purposes it has been shown that less incident radiation is required for the higher kilovoltages and filtrations. Knowing the relative exposures required for the different radiation qualities, the scatter can be corrected to show how much scatter will be obtained with each exposure, for equal film densities. The results of this work are shown in Table III which gives the values of scatter for different kilovoltages and filters when exposures are adjusted to give equal film densities. Films were exposed with intensifying screens and a Potter-Bucky diaphragm was used.

These values reveal the fact that when a fixed volume of phantom is irradiated the scattering remains very nearly constant as the filtration is increased. It also shows that for a given filter the scattered radiation is considerably decreased as the kilovoltage is raised (film density remaining constant). So it is seen that the roentgenographic technician and roentgenoscopist, as well as the patient, are protected by raising the kilovoltage and by increasing the filtration.

TABLE III

QUANTITY OF SCATTERED ROENTGEN RAYS FOR DIFFERENT KILOVOLTAGES AND FILTERS, WHEN EXPOSURES ARE ADJUSTED TO GIVE EQUAL FILM DENSITIES

Kilovolts (Peak)	Milliroentgens of scatter at 24 inches from beam with initial filtration of:			
	0	1 mm. Al	2 mm. Al	3 mm. Al
60	8.6	8.6	8.3	7.4
70	3.8	3.8	3.4	3.2
80	2.3	2.2	2.4	1.93
90	1.8	1.8	1.7	1.65
100	1.5	1.56	1.5	1.43
110	1.5	1.44	1.52	1.34 extrapolated
120	1.39	1.35	1.48	1.32 extrapolated

CONCLUSION

Many of the protection problems that have to be solved in diagnostic roentgenology have been presented. These can be solved by attention to details of technique, by interposition of adequate protective barriers, and by increase of distance from the scattering object when possible. The principles have been discussed upon which changes of quality of the roentgen-ray beam may be used to protect both the patient and the roentgenologist.*

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RADIATION PROTECTION IN THERAPEUTIC RADIOLOGY*

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BECAUSE of the greater efficiency accompanying operation at high tube potentials and because of higher target currents made possible by more efficient cooling of the tube head, the radiation outputs from therapeutic installations are generally larger than from diagnostic units. As a result of this greater output and the greater penetration of the radiation in barriers, the protection problem is a larger economic factor than for diagnostic work. For instance, the cost of lead barriers for a 250 kv. deep therapy unit may be measured in thousands of dollars while adequate protection might be obtained in a diagnostic unit for a few hundred dollars. It is therefore worth while to examine carefully the design requirements. We shall first discuss the origins of the radiation and then indicate possible designs which will provide economic solutions to the protection problem.

All external radiation sources for therapy are now encased in radiation-absorbing source housings provided with an opening for the useful beam. For most therapeutic equipments, the dose rate of the useful beam may be of the order of 1 to perhaps 400 r per minute at 1 meter from the source. The maximum amount of radiation leakage through the source housing permitted by generally accepted codes for roentgen-ray therapeutic housings is 1 r/hr. at 1 meter from the target. All units of recent design meet this requirement. Codes for teletherapy units recommend permissible leakage radiations of not more than 1 per cent of the useful beam measured at the same distance from the source.

Radiation may also be scattered (deviated in direction) when passing through a substance. For protection design, the most important scatterer is generally the patient and the principal scattering arises from the useful beam. The scattered beam is generally somewhat less penetrating and has a much lower exposure rate than the incident beam. Figure 1 shows the origins of the three radiations and their ranges of exposure rates.

The objective of all radiation protection is, of course, to reduce the radiation from those three origins so that it will not exceed the maximum permissible weekly dose of 0.3 roentgens for all positions which may be occupied by personnel. The designer determines the required radiation barriers from a knowledge of the possible directions of the useful beam, the operating time of the equipment per week, and the portion of the operating time during which personnel may be at any potentially hazardous position. Table 1 shows reasonable values for some of the latter positions taken from a report of a committee considering protection for Ra, Co, and Cs sources.[1] Full time occupancy is assumed for all positions which are occupied by radiation personnel. Partial and occasional occupancy include only those positions which may be occupied by persons other than radiation personnel. Under partial occupancy is listed the positions at which a particular person may be during $\frac{1}{4}$ of the operating time of the radiation source. Under occasional occupancy are listed positions which may be occupied for 1/16 of the time.

Since the useful beam is generally more penetrating and more intense than the other two beams, one possible way of re-

[1] National Bureau of Standards Handbook 54, Government Printing Office, Washington 25, D. C.

* Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

TABLE I

OCCUPANCY FACTORS

Full Occupancy (T = 1)
Control space, residences, wards, office work-rooms, dark-rooms, corridors and waiting space large enough to hold desks, rest rooms used by the radiologic staff and others routinely exposed to radiation, recreational areas.

Partial Occupancy (T = 1/4)
Corridors in roentgen-ray departments too narrow for future desk space, rest rooms not used by radiologic personnel, parking lots, utility rooms.

Occasional Occupancy (T = 1/16)
Stairways, automatic elevators, streets, closets too small for future work-rooms, toilets not used by radiologic personnel.

ducing the cost of radiation protection is to reduce the area of the barrier which may be struck by the useful beam. This may be done by either restricting the angulation of the useful beam or by providing a radiation "catcher" which is always located in the useful beam. Figure 2 shows a possible arrangement for a 250 kv. (peak) therapy installation.[2] While this is not considered to be an ideal design, it does illustrate some design features which are of interest. Lead is to be used for the barrier.

In the first case, the beam may be pointed in any direction for an assumed operating time of forty-eight hours per week. Since the time that the beam is to be pointed at any wall generally cannot be specified, the protection designer usually requires that each wall provide protection for the entire forty-eight hours per week. It may be assumed, however, that the beam will not be pointed toward the ceiling for more than one-eighth of the time. In addition, the hall is narrow and cannot be used for future office space so the barriers A and I provide protection for only twelve hours per week as indicated in Table II. All other walls provide protection for forty-eight hours per week. The existing wall, J, has a lead equivalent of 1.6 mm. This assists in the protection of persons in the space beyond J. The barrier requirements for unrestricted orientation of the beam are given in Column 2 of Table II. Now let us assume that permissible mechanical re-

[2] National Bureau of Standards Handbook 50, Government Printing Office, Washington 25, D. C.

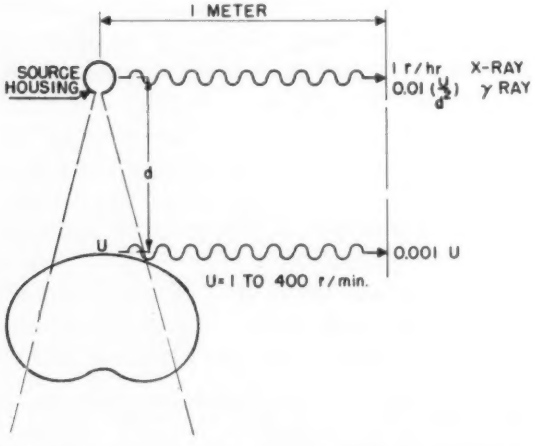

FIG. 1. Origins of radiation for which protection must be provided.

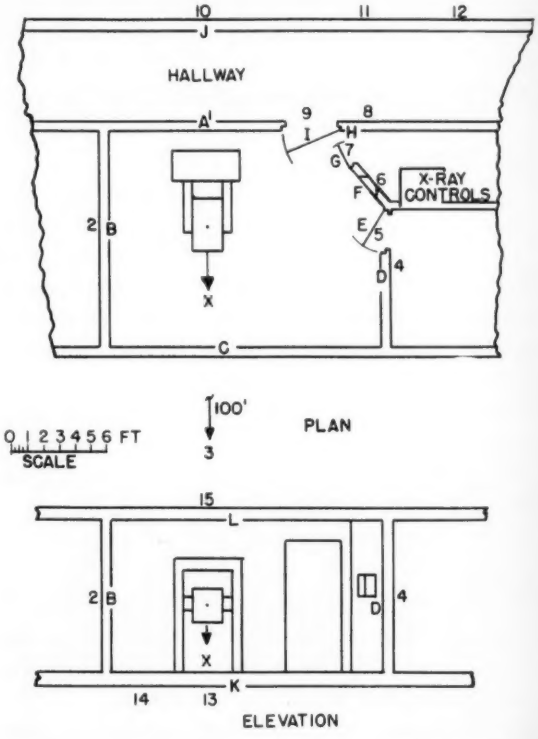

FIG. 2. A 250 kv. (peak) therapy installation. The letters indicate the protection barriers and the numbers the positions which may be occupied by personnel.

Fig. 3. A teletherapy unit. *B* is the source housing; *A* provides radiation protection against the useful beam.

Table II

PROTECTION REQUIREMENTS FOR INSTALLATION IN FIGURE 2

Barrier	Barrier Thickness. (mm. lead)			
	Case			
	I[a]	II[b]	III[c]	IV[d]
A	7.3	2.8	4.9	1.3
B	9.3	9.3	6.9	6.9
C	3.2	3.2	1.5	1.5
D	8.1	3.7	5.7	1.9
E	8.2	3.7	5.8	1.9
F	7.6	3.4	5.4	1.7
G	7.7	3.7	5.6	1.9
H	3.3	1.1	2.0	0.4
I	4.5	1.5	2.8	0.6
K[e]	2.0	2.0	1.5	1.5
K	7.0	7.0	5.1	5.1
L	6.9	6.9	4.5	4.5

[a] All barriers exposed to useful beam for 48 hours per week.
[b] Restricted useful beam (see text) for 48 hours per week.
[c] All barriers exposed to useful beam for 6 hours per week.
[d] Restricted useful beam (see text) for 6 hours per week.
[e] This is an extra barrier just below the roentgen tube and of about 3 foot radius.

strictions of the tube do not permit the useful beam to strike walls D, H, A, doors E, G, I, and window F. Column 3 of Table II indicates the lead equivalent required for these barriers under this condition. It may be seen that a saving of approximately one-half the protective barrier thickness is obtained by this procedure for the walls which are not struck by the useful beam.

Figure 3 shows another method of obtaining similar results. This shows a cobalt teletherapy unit[3] designed by C. B. Braestrup and the Atomic Energy of Canada, Ltd. This unit is arranged for rotational therapy. The counterbalance is a large piece of lead which also serves as a catcher for the useful beam. Thus none of the walls are struck by the useful beam. In this way, the barrier thickness is approximately one-half of that required without the lead.

Another factor which might provide some economic advantage would be in the

[3] Courtesy of C. B. Braestrup, Director of Physics Service, City of New York, Department of Hospitals.

TABLE III

BARRIER WEIGHTS AND COSTS FOR 250 KV. THERAPY MACHINE

	Case I[a]	Case II[b]	Case III[c]	Case IV[d]
Lead weight (pounds)	12,000	9,000	7,000	5,000
Cost (dollars)	5,500	4,300	3,700	2,800
Cost of floor and ceiling protection (dollars)	1,000	1,000	700	700

[a] All barriers exposed to useful beam 48 hour work week.
[b] Restricted useful beam (see text) 48 hour work week.
[c] All barriers exposed to useful beam 6 hour work week.
[d] Restricted useful beam (see text) 6 hour work week.

proposed running time of the machine per week. In most examples it is assumed that the running time in therapy installations will be forty-eight hours per week. Recently there has been some information collected on the actual running time of therapy machines. Dr. Dale Trout[4] has summarized the results from 264 machines. He finds their operating time varies from less than three to approximately forty hours per week. About $\frac{1}{4}$ of these machines were used less than three hours per week but $\frac{1}{3}$ were used more than ten hours per week. Other information from Dr. Frank Hoecker[5] indicates that some therapy machines might be run as little as 0.4 hours per week. Thus, if one could predict the time per week during which a machine would actually be used, one might be able to reduce the *attenuation* requirement of the radiation barrier by a factor of from 2 to perhaps 150. This does not, of course, mean that the cost of the protection is reduced by this amount. Columns 4 and 5 of Table II show lead thicknesses required for six hours' operation per week, of the installation in Figure 2, for an unrestricted useful beam and for a useful beam restricted as in the previous example.

The cost of radiation protection arises from the material and labor cost for the room in question and from the possible increase in structural requirements to support the heavy weights involved. Since the second item depends upon the building design rather than the protection, only the weight of the protective material will be estimated. Let us consider the 250 kv. therapy installation just discussed.

It will be assumed that this is a new installation in which lead-cinder block sandwiches are used for the walls and that sheet lead may be placed in the floor and ceiling during their construction. Wall blocks now cost about $1.10 per mm. thickness of lead[6] per sq. ft. area and installation costs an additional $.50 per sq. ft.[6] Sheet lead for the floor and ceiling costs about $.66 per mm. per sq. ft.,[6] and installation is about $.40 per sq. ft.[6] It will be assumed that these material costs apply down to 1.5 mm. thick lead and that thicknesses below 1.5 mm. will not be used. For thicknesses below 1.5 mm. there is an extra handling cost which makes them uneconomical. In addition, it will be assumed that the floor and ceiling are made of 6 inch thick concrete having a lead equivalent of 3 mm.

Table III shows the results computed for 4 cases. In the first case the useful beam is unrestricted and the unit operates for forty-eight hours per week; in the second case the operating time is only 6 hours per week; the third case gives results for the orientation restriction of the useful beam already considered and for operation of forty-eight hours per week; the fourth case is for limited orientation and six hours' operation per week. Table III also indicates that $1000 of the cost for Cases I and III and about $700 for Cases II and IV are for floor and ceiling protection. If this room is in the basement or on the top floor about one-half of this cost may be saved. Thus, depending upon the conditions given the designer, the protection cost may vary by

[4] Private communications.
[5] Teletherapy Evaluation Board, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee.
[6] Estimate from costs of 3.0 and 6.5 mm. thicknesses of lead supplied by Bar-Ray Products, Inc., 209 25th Street, Brooklyn 32, New York. Shipping costs are not included.

more than a factor of 2 or 3.

Careful consideration of both the expected work load in the foreseeable future and possible restrictions in the orientation of the useful beam are therefore regarded as the most fruitful direction for reducing the cost of radiation protection.

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DISCUSSION OF SYMPOSIUM ON RADIATION PROTECTION

(Papers by A. H. Dowdy, G. C. Henny and H. O. Wyckoff)

L. D. Marinelli, Ph.D., Lemont, Illinois. I am certain that the members of this audience are grateful to the organizers and the speakers of this symposium for a concise presentation of a vast subject.

On account of the limited fundamental knowledge available, we can protect ourselves from radiation today only by limiting the amount of radiation reaching our tissues. The formulation of these limits has been the object of considerable work on the part of the National Committee on Radiation Protection and its subcommittees. As a participant in some of this work I could not help wondering at the vast simplification that would have ensued if the mechanism of radiation carcinogenesis, for instance, were understood at least in its general aspects.

Dr. Dowdy has already mentioned the clinical observations on humans; I wish to emphasize that they are at present insufficient to yield with any precision the probability of injury following most of the radiation exposures envisioned today. The store of our knowledge must be expanded at the clinical level if we are to draw relevant conclusions from experiments on the laboratory animal. Much of the privilege and of the duty to expand this knowledge rests with the radiological profession. These remarks do not imply that there has been a lack of reports on the subject in the radiological literature but rather that the emphasis should be shifted from the more or less qualitative observation of the past to a more detailed analysis of dose parameters and consequent effects. To assume statistical significance these inquiries may require pooling of results from institutions using similar irradiation techniques and comparison of results among groups employing different techniques. An example of what can be accomplished has already been demonstrated by a recent report on late carcinogenesis following irradiation of the skin.

Much could be learned from similar approaches on bone injury following irradiation of pelvic bone during treatment of carcinoma of the cervix. It seems to me—and I wish to be corrected if wrong—that a study of the dose delivered to bone following treatment of hemangiomas and observation of late effects should be particularly fruitful because of the high incidence of this nonlethal affliction and the wide variety of treatment techniques employed.

To Dr. Henny we are indebted for his keen summary of the protection problems arising in a diagnostic department and in particular for his illustration of the influence of the voltage on the amount of scatter from the patient. It is indeed interesting to note that this most important protection parameter decreases sharply when the kilovolts (peak) are increased from 60 to 70. It would be most useful, on the other hand, to evaluate the consequences of such voltage increase on (a) the cost of the equipment; (b) the cost of the protective barriers, and (c) the quality of the roentgen image.

Dr. Wyckoff, true to the noble traditions of the National Bureau of Standards, has aptly emphasized the economic factor involved in the construction of protective barriers for radiotherapeutic installations. Having been concerned with the problem in a few instances, I can only add that restriction in the treatment area can also decrease the cost of radiation protection. This, of course, is conditioned in part by the choice of the equipment and the exclusion of some accessories from the treatment area. An impartial survey of costs in typical installations would be most useful but I don't know that any exhaustive information of this kind is either available or has been given wide circulation. While this information might lead to unavoidable implications as to the desirability of certain types of machines it cannot in itself be decisive without taking into account the potential productivity of the final setup.

Personally, I have been dismayed at the neglect paid to the economic factor of protection in practical hospital planning. The choice of a layout has seemed almost always beyond the dictate of scientific logic, except in times of severe economic stringency. Predominant, in my expe-

rience, has been the claim of the radiotherapist for complete freedom of the roentgen-ray beam on the grounds that the patient should lie almost always supine for better localization and that the roentgen-ray beam should be operative in any direction in order to obtain the highest benefit of crossfire under the most diverse conditions.

With regard to radiation protection in radioisotope laboratories, I may conclude by pointing out that in hospitals the great majority of isotopes used in large quantities are of short half-life because of the very nature of the therapeutic procedures intended and that if accidents occur they are likely to be manageable both administratively and economically. In particular the gamma-ray emitters administered to patients can only rarely irradiate personnel any more than the amount of radium used routinely in treatment of carcinoma of the cervix. It follows, therefore, that no special barriers are needed and that the additional precautions necessary are confined to those required by wise housekeeping.

Dr. Dowdy (closing). In closing, I would like to summarize briefly.

Dr. Henny's paper reminds us again of the fact that the patient as well as the radiologist must be taken into consideration, and when you find with one pelvic examination the ovaries may receive as much as 3.5 roentgens, you can readily see that if you do ten or fifteen examinations on any one individual, particularly the young woman, you are getting to the point where you might expect some damage to subsequent offspring from genetic changes.

So, each time we have a patient we should use a minimum amount of radiation necessary with the utmost caution, since one never knows how long these people are going to live, and how many times year after year they are going to be roentgenographed.

We are trying something in our Department of Radiology at Los Angeles which maybe a few years from now we can tell you about in more detail. We have placed all of the control panels of the diagnostic equipment into what we call a control corridor, a 5 foot corridor which extends around the front end of each of the radiographic rooms separating them from a central dark room. The roentgen tube cannot be energized until the door to this control corridor is closed. There is an intercommunicating system so one can communicate with the patient. If the technician gets any exposure, we will know he has jammed the contact by inserting toothpicks or the like in the switch and thus made contact without closing the door.

I would particularly dislike for us especially in large hospitals to calculate the economy quite as closely as Dr. Wyckoff has suggested, since, as Dr. Marinelli pointed out, we never know what kind of patient problems we are going to encounter. So, we want the greatest degree of flexibility. Therefore, I feel all the walls should be adequately protected.

Again, I don't think we should figure on perhaps running or operating a machine one-tenth of an hour or three hours per day, rather protection should be provided for maximum utilization of any particular room, with due consideration for the technicians and doctors in the control booth and adjacent areas. One may be putting one's head in the sand like an ostrich if you try to save a few hundred or thousand dollars in the original construction since you may have to add more at a later date, at which time the expense of accomplishing sufficient protection may run into prohibitive figures.

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THE QUANTITATIVE DETERMINATION OF GAMMA-RAY EMITTING ELEMENTS IN LIVING PERSONS*

By L. D. MARINELLI, C. E. MILLER, P. F. GUSTAFSON, *and* R. E. ROWLAND
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THE problem of evaluating the quantity of a gamma-ray emitting element contained in the intact human body has been considered by several workers concerned with the problem of radium toxicity in humans. The earliest attempts consisted in comparing with the same instrument the gamma-ray activity of living individuals either with that of persons who later came to autopsy, or with that of cadavers implanted with known amounts of radon "seeds." The shortcomings of these empirical methods were discussed by R. D. Evans[3] in 1937 when he described the basis of a new approach designed to improve both the sensitivity of the measurements by the use of Geiger-Müller counters, and their accuracy by the use of procedures aimed at minimizing the influence of the uneven distribution of radium in the body. More recently, Mayneord[8] has considered the problem from a theoretical standpoint, whereas Sievert,[12] Spiers and Burch,[2,14] Taylor *et al.*,[17] and Reines *et al.*[10] have described apparatus of "4π geometry" endowed with remarkable over-all sensitivity.

The method used by us in our study of radium toxicity in humans originated in 1950 as a duplication of Evans' technique, except for the substitution of a scintillation counter for the less efficient Geiger-Müller detector. As work progressed, however, certain modifications in procedure, aimed at simplification and greater over-all accuracy, were found desirable and put into effect. Instead of discussing the modifications in chronological detail, the method will be presented herein from basic principles in the interest of clarity and coherence.†

THE DETECTOR

The detector consisted of a NaI(Tl) cylindrical crystal 2.25 inches long and 1.5 inches in diameter sealed in an aluminum cap by the method of Swank and Moenich.[16]‡ Scintillation pulses were detected by an RCA 5819 photomultiplier tube attached to a linear amplifier furnished with a pulse height analyzer of variable channel width, and connected to a scaling circuit and register. The stability of this instrument has been very satisfactory, as evidenced by the fact that the net counting rate elicited from a Ra source, used in reproducible conditions, has not varied more than a few per cent over a period of several years. The efficiency of the counter, expressed in total counts per single incident photon, was determined as a function of energy by exposing the long axis of the crystal to "point" sources of monoergic photons,§ the flux of which was calculated from the emission in roentgens per hour as measured by means of an "air wall" thimble chamber calibrated with a Ra source.[7] The results sre shown in Figure 1 where they can be compared with those reported by Sinclair[13] on Geiger-Müller counters having copper and lead cathodes. It will be noted that when all scintillations are counted, the photon efficiency of a thick NaI crystal is not only much higher, but it is also much less dependent on photon energy than that of a Geiger-Müller counter. Moreover, when one restricts counting to scintillations within a particular energy band, the response of the instrument can be modified considerably. Thus, if scintillations corresponding to secondary elec-

† A rather concise presentation of our work, as a straight modification of Evans' method, has been reported elsewhere.[6]

‡ Additional shielding was provided to exclude radium beta rays.

§ Hg^{203}, Cs^{137}, Co^{60}, Na^{24}.

* Presented at the Seventh International Congress of Radiology, Copenhagen, Denmark, July, 1953.

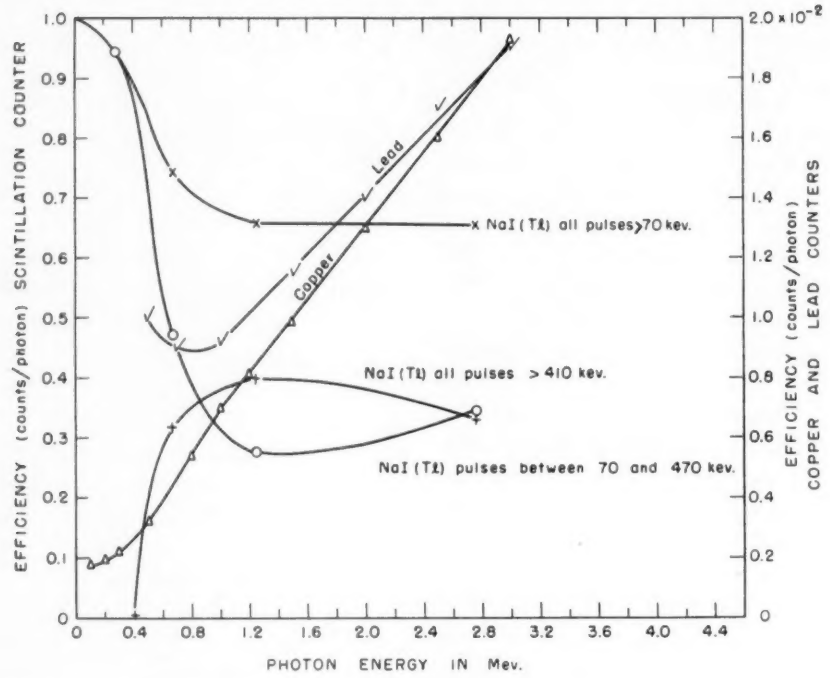
EFFICIENCY (counts/photon) SCINTILLATION COUNTER
EFFICIENCY (counts/photon) COPPER AND LEAD COUNTERS
PHOTON ENERGY IN Mev.
Lead
Copper
x NaI(Tl) all pulses>70 kev.
NaI(Tl) all pulses >410 kev.
NaI(Tl) pulses between 70 and 470 kev.

FIG. 1. Efficiency of NaI(Tl) crystal as a function of photon energy for various pulse height bands.

tron energies comprising between 70 and 470 kev. only are recorded, the efficiency for high energy photons can be reduced roughly twofold, whereas if scintillations of energy between 0.47 and ∞ kev. are recorded, the detecting efficiency above the threshold is likewise reduced, but that below 410 kev. is automatically reduced to zero. The two pulse height bands just mentioned have been used either singly or jointly in our measurements in order to determine the consistency of the method. They will be referred to in the text as the low energy and high energy channel, respectively.

It should be realized at this juncture that the "spectrometric" property of the scintillation counter can sometimes be exploited to improve the sensitivity and/or the precision of the measurements whenever the signal to background ratio varies substantially over the pulse height spectrum.

THE BACKGROUND RADIATION

Preliminary measurements showed that the background radiation from walls and floor of ordinary laboratory rooms was large enough to limit severely the usefulness of our instrument; therefore we attempted to overcome this difficulty by suitable shielding.

As an over-all figure of merit of the suitability of prospective setups we have chosen the quantity $p^{-2}T^{-1}$, where p is the fractional standard deviation of the signal measurement and T is the minimum total counting time necessary to attain it. This quantity can be calculated[5] according to the expression:

$$p^{-2}T^{-1}=n_2(r^1-1)^2 \qquad (1)$$

where

n_2 = background counting rate; n_1 = signal net counting rate and $r=(n_1+n_2)/n_2$. $T=t_1+t_2$, where t_1 = time taken to measure signal plus background and t_2 = time to measure the background alone. The minimum combined time is attained when $t_1/t_2=r^{\frac{1}{2}}$.

Equation (1) shows that for a given p or T, either T or p will be a minimum whenever the product in the second term is a

TABLE I

EFFECT OF SHIELDING AND PULSE HEIGHT BAND ON FIGURE OF MERIT

Shielding, inches*					Scintillation Counter			Bismuth Counter		
(1) Room	(2) Floor	(3) Wall	(4) Crystal	(5) Channel, kev.	(6) n_2	(7) r	(8) $n_2(r^{\frac{1}{3}}-1)^2$	(9) n_2	(10) r	(11) $n_2(r^{\frac{1}{3}}-1)^2$
A	None	None	None	40–∞	7741	1.076	9.5	140	1.08	0.224
	None	None	None	40–370	6600	1.075	8.1			
	None	None	None	150–520	1684	1.093	3.0			
	None	None	None	600–970	817	1.10	1.9			
A	None	None	⅛	40–∞	2217	1.26	32	80	1.14	0.389
	None	None	⅛	40–370	1233	1.40	40			
	None	None	⅛	150–250	889	1.18	6.4			
	None	None	⅛	600–970	568	1.15	2.8			
A	None	None	¼	40–∞	1564	1.37	45	70	1.16	0.415
	None	None	¼	40–370	847	1.59	57			
	None	None	¼	150–520	616	1.26	8.9			
	None	None	¼	600–970	457	1.18	3.3			
B	None	⅛	¼	40–∞	994	1.59	67	58	1.19	0.470
	None	⅛	¼	40–370	487	2.01	86			
	None	⅛	¼	150–520	371	1.44	15			
	None	⅛	¼	600–970	285	1.29	5.2			
C	None	¼	¼	40–∞	614	1.95	96	50	1.22	0.540
	None	¼	¼	40–370	284	2.74	120			
D†	½	¼	1¼	70–∞	627	1.83	79			
	½	¼	1¼	70–470	371	2.09	74			
	½	¼	1¼	410–∞	310	1.47	14			
E	None	None	8(Fe)	40–∞	93	7.3	270			
	None	None	8(Fe)	40–370	64	8.7	242			
E‡	None	None	8(Fe)	40–∞	63	10.2	305			
	None	None	8(Fe)	40–370	56	9.8	250			
	None	None	8(Fe)	370–∞	9.0	10.4	44			

* Lead unless stated otherwise.
† Hemicylindrical shield around crystal.
‡ Anti-coincidence Geiger-Müller counter shield around crystal.

maximum. In anticipation of the requirements to be met in the measurements of our patients, 1 μg. of Ra in equilibrium with its daughters placed in air at the distance of 1 meter was chosen as our signal source, and n_2 and r were determined within certain channel bands under various conditions of shielding. The latter was available either on the walls of some existing roentgen-ray rooms* or was placed closely around the crystal, which, like the source, was held at a height of 70–100 cm. from the floor. The results of our quest, though by no means exhaustive, are of sufficient interest to justify their summary in Table 1. It will be noted that the signal to noise ratio $n_1/n_2=r-1$ does not vary appreciably, percentagewise, with the channel band when the shielding is either nonexistent or heavy enough (8″ Fe) to drastically reduce the radiation from the masonry walls. These observations are consistent with the assumption that the background radiation from very thick layers of either masonry or iron is substantially similar in quality to that from unfiltered radium in equilibrium with its products.

The data of Table 1 (Column 8) demonstrate also that for measurements of activities comparable to our signal, the detection of low energy pulses (<500 kev.) is to be preferred to the detection of all incoming pulses where moderate thicknesses

* Cinder block or brick walls; concrete floors.

($<\frac{1}{2}''$) of lead shielding are available. These findings are consistent with the fact that lead, on account of its high atomic number, transmits to the crystal a fraction of RaB radiation lower than would be transmitted by a masonry wall. Although some improvement in the figure of merit might be obtained by restricting the channel width to lower energies, it was thought best not to press this advantage further because it soon became evident that it would have engendered uncertainties in the over-all accuracy of the measurements on patients (*vide infra*). For reasons of economy the shielding was limited to $\frac{1}{4}''$ Pb on the walls and to $\frac{1}{2}''$ Pb over the concrete floor of a room 8′ high, 8′ wide, and 10′ long. The crystal was further shielded by a half cylinder of $1\frac{1}{4}''$ of lead on the side opposite that facing the patients (Room D of Table 1).

It is of interest to note at this point that the figure of merit can also be expressed as a function of n_1 and r as follows:

$$p^2T=n_1^{-1}[1+2(r^{\frac{1}{2}}-1)^{-1}]$$

which shows that obliteration of the background ($r=\infty$) would lead to a figure of merit equal to n_1 (in our case about 520) when all pulses from radium are counted. We may infer, therefore, that for a given precision p, the counting time necessary to achieve it with our setup is about seven times the minimum possible, whereas with a shielding of 8″ of iron this factor could have been lowered to a value of about two.

The inherent advantages of the scintillation counter over an ordinary Geiger-Müller counter with bismuth cathode can readily be appreciated by inspection of the relative figures of merit shown in Table 1. In our measurements on patients, all background readings were taken with a nonexposed individual placed identically with respect to the counter as the patient under observation; this procedure was found necessary to equalize in both instances the sizeable number of photons which are emitted by the walls and later scattered into, or excluded from, the crystal by the human body under scrutiny.

In order to assess the extent to which differences in the potassium content of the human body might affect our measurements, the net counting rate of all pulses from 250 grams of potassium was measured at a distance of 16 cm. from the counter and found to correspond to the counting rate induced by 0.015 μg. of radium under the identical conditions, a value remarkably close to that obtained by others.[2,12] It is obvious, therefore, that since most of our patients were burdened by more than 0.1 μg. of Ra, a variability in total body potassium content as great as 100 grams from the control* could not have produced an uncertainty exceeding 4 per cent in our measurements of Ra burden. This conclusion is not altered substantially by the choice of the channel used, because the efficiency of the crystal does not change appreciably over the range of energy covering the bulk of the gamma radiation from Ra (B+C) and the gamma ray from potassium (Fig. 1).

Before proceeding further, it is well to realize that the estimates of total radium content of the body are based essentially on the α-ray measurement of the time rate of radon exhalation,[15] and the measurement of the amount of radon retained in the body by the gamma-ray activity of Ra (B+C). Since radium itself, however, emits 3 to 3.8 photons of 186 kev. energy per 100 alpha disintegrations[4] and about 70 per cent of the radon produced is exhaled,[9] the actual radiation emitted by the body originates from a nonequilibrium mixture of Ra^{226} and Ra(B+C) gamma rays.† If—as we have done—this radiation is compared to a sealed, but unfiltered, source of Ra as standard, some uncertainty may be introduced when the lower energy channel (70–470 kev.) of the instrument is used. In order to estimate its magnitude, the Ra ampule

* The potassium content of a 70 kg. man is estimated to be approximately 150 grams.[2,10]

† Photon radiation from RaD was eliminated in all instances by choice of the lowest bias (70 kev.).

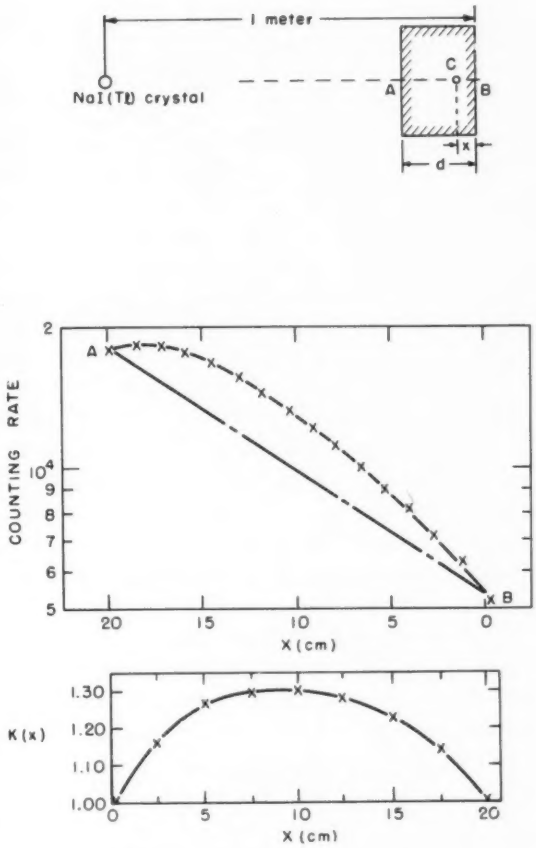

FIG. 2. Schematic setup, reciprocal depth dose curve and scattering correction coefficient for 30 by 30 by 20 cm. phantom.

was compared using both channels, in air and within a presdwood phantom (*vide infra*), at a depth of about 5 cm.,* with an unfiltered glass radon seed in equilibrium with Ra (B+C). The readings of the higher energy channel were not influenced by the 186 kev. radiation from Ra^{226} and hence served as normalizing factors of the disintegration rates of both sources. As expected, the lower channel recorded more counts per disintegration in the presence of radium; specifically, by a factor of 1.14 in air and 1.06 in the phantom. In anticipation of a radon retention *in vivo* of the order of 30 per cent of the equilibrium amount,[9] we may surmise that the sum of the Ra^{226} and Ra (B+C) counts from the body was about (6/0.3) 20 per cent in excess of the reading due to the retained Ra (B+C); on the other hand, since the standard of reference, Ra^{226}+Ra (B+C), yields a counting rate 14 per cent higher than the equivalent radon standard, the estimates of retained radon activity could have been as high as 6 per cent in excess of the correct value, but the error in the body burden would not have exceeded 2 per cent. This figure is negligible compared to the remaining uncertainties.

The very difference between the pulse height spectra of radium and radon, when both are in equilibrium with their daughters, can sometimes be exploited to ascertain the fraction of radon retained *in vivo* without recourse to measurement of radon exhaled in the breath of animals. This technique is at present under investigation in our laboratory.

PRINCIPLES OF MEASUREMENT

In addition to the necessity of reducing the background radiation and of increasing the signal to noise ratio by suitable pulse selection, there remained the problem of evolving a calibration method capable of yielding a correct estimate of the retained radon, irrespective of its location in the body.

The distal face of presdwood phantoms of 30 by 30 cm. area and 15, 20 and 30 cm. thickness was placed at 100 cm. from the detector, and the counting rate was observed as a function of distance from the detector as the source was moved along the axis of the phantom (Fig. 2). The function, plotted semilogarithmically in the same figure, was found to resemble a "depth dose curve," as would be expected from the "reciprocity" principle of Sievert;[11] moreover, the slopes of the straight lines joining the points representing the counting rates at both surfaces of the phantom were found sensibly constant for the three phantom thicknesses investigated at a given distance, provided that a single radioelement was used and single channel width was selected (Fig. 3). It is obvious, therefore, that

* Estimated to be roughly the average depth of chronic Ra deposits in the body (*vide infra*).

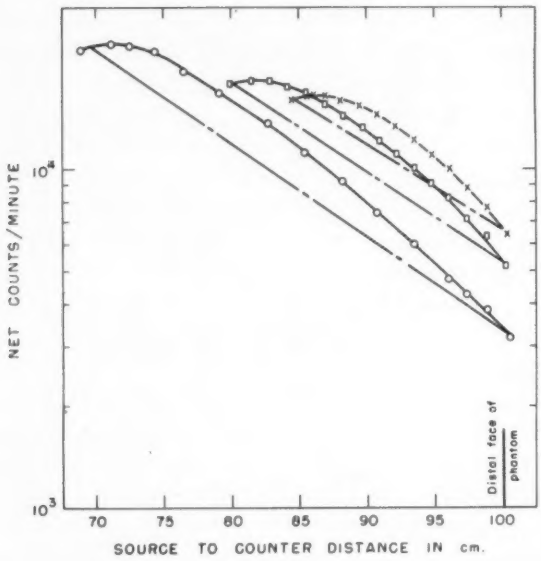

Fig. 3. Reciprocal depth dose curves for presdwood phantoms 15, 20 and 30 cm. thick in the presence of radium—low energy channel.

the net counting rate N_1 from a point source of S μc., situated on the axis of the phantom at any depth X cm. from the distal surface of the phantom, can be expressed in terms of an exponential function and a correction factor $K(X)$ correlating the true depth activity to the activity calculable from the exponential. More precisely, we can express the counting rate N_1 by an expression such as:

$$N_1 = SN_3 e^{\mu' X} K(X) \qquad (2)$$

where N_3 is the net counting rate obtained from 1 μc. of element placed at B.* The fictitious absorption coefficient μ' is given by the slope of straight lines AB (see Table II), and $K(X)$ is the ratio of the ordinates of the depth dose curve to that of the straight line at point X. The function $K(X)$ is shown at the bottom of Figure 2 as a function of depth of the source. If the source is fixed in the phantom and the proximal and distal surfaces of the latter are reversed in position, the resulting net counting rate N_2 will be:

$$N_2 = SN_3 e^{\mu'(d-X)} K(d-X) \qquad (3)$$

where d is the thickness of the phantom. From (2) and (3), solving for S, one obtains:

$$S = \frac{(N_1 N_2)^{\frac{1}{2}}}{N_3} e^{-\mu' d/2} [K(X)K(d-X)]^{\frac{1}{2}}. \qquad (4)$$

It will be seen that this expression depends on the depth X of the source only through the function in the square bracket. This function is shown in Figure 4 to be rather insensitive to both the thickness of the phantom and as to whether Ra or Na^{24} radiation was used. The absolute values vary at most by only 8 per cent when the source is moved from the surface to the center of the phantom if the high energy channel width is used, whereas the variation for the same conditions may be as high as 25 per cent with the lower energy channel. This phenomenon is due to the degradation of the radiation in the phantom and the efficiency function of the particular channel (Fig. 1). We may conclude, therefore, that in estimating the activity of a line source of unknown linear density and length located on the axis of a phantom of known thickness, no error greater than roughly one-half the above limits can be caused by the use of Equation (4).

Extension of this simple, but rigorous, analysis to a hypothetical distribution of radium in the human body was considered a hopeless task. Experiments were nevertheless performed to assess the influence of

Table II

Values of fictitious absorption coefficient μ'

Source	Energy Band (kev.)	μ'
Ra	Low 70–410	0.0615
Ra	High 470–∞	0.0558
Na^{24}	Low 70–410	0.0389
Na^{24}	High 470–∞	0.0433

* The reading N_3 was routinely obtained by using a well established absorption curve (broad beam) in presdwood and an air reading at 1 meter. This procedure permitted a constant check on the sensitivity of the instrument and reduced the time of observation on the patients. The latter, in any case, proved to be unsuitable "material" for the absorption curve.

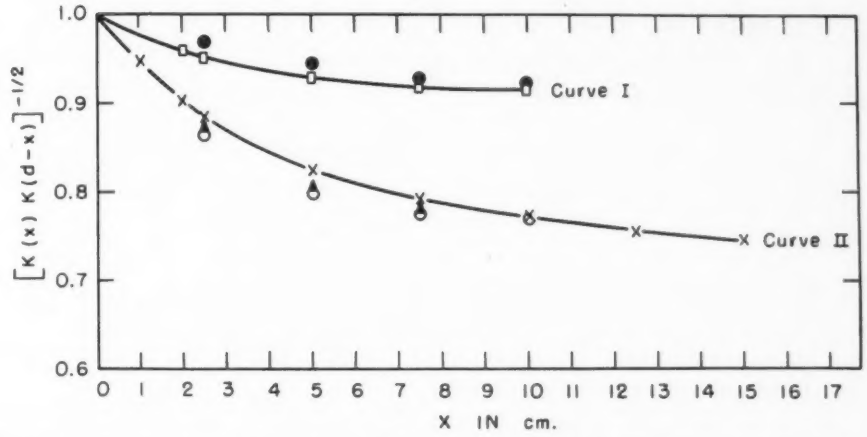

FIG. 4. Scattering correction coefficients in presdwood phantoms. Curve II. Low energy channel: x=30 cm., O=20 cm., △=15 cm. thickness. Curve I. High energy channel: thickness of phantom 20 cm., ●=Na^{24} source; □=Ra source.

the frontal width of the phantoms and of the proximity of the source to their edges. Both were found negligible (±3 per cent) when the high energy channel was used with either Ra or Na^{24} radiation. With the lower and more sensitive channel, the increase in N_1 was 17 per cent for a Na^{24} source and 13 per cent with Ra when the source was at the center, and the face of the phantom was increased from 30 by 20 cm. to 30 by 60 cm. Proximity of the source to the edge (4.5 cm. instead of 15 cm.) decreased readings at all depths by amounts varying from 8 to 4 per cent. Although these readings were hardly sufficient to supply information of practical import, they showed a consistent similarity of the variations observed with Na^{24} and Ra radi-

TABLE III

EVALUATION OF ACCURACY AND CONSISTENCY OF METHOD IN VIVO

Subject	Weight (lb.)	Element	Time	Ratio of Estimated to Actual Amount*		Ratio of Estimates†	Standard Deviation of Ratio (Statistical)
				Channel I	Channel II		
L.D.M.	155	Na^{24}	20 min.	1.03	1.07	0.96	±0.021
L.D.M.	155		35 min.	0.99	1.08	0.92	±0.021
L.D.M.	155		110 min.	1.01	1.09	0.92	±0.021
L.D.M.	155		20 hr.	0.93	1.11	0.84	±0.031
T.T.	176	Na^{24}	10 min.	1.09	1.11	0.98	±0.053
T.T.	176	Na^{24}	5 hr.	0.94	1.11	0.85	±0.056
J.W.	96	Na^{24}	10 min.	1.03	1.14	0.90	±0.052
J.W.	96		3 hr.	0.94	1.12	0.84	±0.054
No. 104		Ra	>20 yr.	—	—	1.09	±0.03
No. 106		Ra	>20 yr.	—	—	1.05	±0.053
A		Ra	>20 yr.	—	—	0.82	±0.163
L		Ra	>20 yr.	—	—	0.93	±0.044
N		Ra	>20 yr.	—	—	0.92	±0.15
R		Ra	>20 yr.	—	—	0.96	±0.082

* Channel I—40–410 kev.
Channel II—0.47–∞ mev.
† Ratio of results obtained with Channel I to those obtained with Channel II.

ation, and suggested a trial of the "geometrical" accuracy of the method *in vivo*, using a few microcuries of the shorter lived element.

This was performed on three individuals weighing 96, 155 and 178 pounds, respectively. They reclined on a light, wooden table, along an arc of a circle 1 meter in radius from the detector, as suggested by Evans. The average depth d was estimated by the arithmetic average of the antero-posterior thickness at mid-sternum, at the navel, and at mid-thigh; the coefficient μ' was taken from the values of the "standard" presdwood phantom (Table II). N_1 and N_2 were measured with the subjects facing respectively toward and away from the counter, and N_3 was determined with an amount of Na^{24} equal to the dose ingested by these subjects. Formula (4) was applied, and the average depth x, needed for the choice of the scattering correction (Fig. 4), was assumed to be 6.3 cm.* The results evaluated at various times after administration of Na^{24} are shown in Table III as the ratio of calculated values to true body content. It will be seen that although the lower energy channel was expected to be less accurate, because of the greater uncertainty in the corrections, the opposite was found. We are at a loss to explain this anomaly except on the basis of a fortuitous combination of circumstances. There is some evidence, however (as shown by the greater variations in the burden estimates with the time elapsed from the time of administration of Na^{24}), that the lower channel (1) yields results more susceptible to location of Na^{24} in the body. These data confer confidence in the method and set the uppermost limit of the probable "absolute" geometrical error (excluding statistical errors of counting) at either 10 per cent or 5 per cent, according to whether the estimates are based on a single channel reading, or on the average of both.

* This value is anatomically sound and yields also consistent results with the radium patients; in any case, errors as large as 25 per cent in its magnitude could not have affected the results to any great extent.

Although, for obvious reasons, the absolute accuracy of the method could not be tested with radium in humans, the gamma activity calculated with the operation of one channel was found to be consistent with the value calculated from the measurements performed with the other channel. The extent of the agreement is shown also in the lower part of Table III together with an estimate of the "counting" error. In this comparison no allowance was made for the error inherent in the choice of radium as a standard and affecting the results of Channel 1 only (*vide supra*).

Additional evidence of the self-consistency of the method was obtained on a human subject whose excretion of Ra, following accidental inhalation of $RaSO_4$, was followed for a period of over six months. This evidence has been presented elsewhere,[6] and the reader is referred to this article for details. An equally satisfactory check (± 5 per cent) was obtained in the case of one dog for which the actual Ra content was determined by direct analysis of the whole carcass. It must be realized, however, that in the two instances just mentioned, the discrepancy between calculated and experimental values cannot be considered strictly as representative of the error involved in the gamma-ray method, since estimates of total radium content required also measurements of the exhaled radon in the living body; these, in turn, are strongly dependent on many physiological factors at the time of test.[9] Another dog, sealed in a pliofilm bag and kept frozen after death, was measured until the gamma-ray activity reached equilibrium. The latter was found to agree (± 2 per cent) with the chemical analysis of the carcass. The parameters of Equation (4) were determined with a phantom of 15 by 15 by 30 cm. size whenever measurements on dogs were undertaken.

DISCUSSION

A sufficiently useful evaluation of the practical sensitivity of our setup can readily be made from Equations (1) and (4) by

utilizing the data of Table 1. The latter indicates that in our present room (D) with the lower energy channel the background is 371 c/m. and that 1 μg. of radium at 1 meter yields 405 c/m. If, for practical purposes, we restrict the standard statistical error P of S to 20 per cent, we see from Equation (4) that

$$P=(\tfrac{1}{2}p_1^2+\tfrac{1}{2}p_2^2+p_3^2)^{\frac{1}{2}}=0.20$$

where p_1, p_2, and p_3 are the fractional errors in the net readings N_1, N_2, and N_3, respectively. By suitable choice of a radium standard, p_3 can be made negligibly small compared to the others, and in practice we have found $N_1 \cong N_2$; consequently for about equal counting time of N_1 and N_2, $p_1=p_2$ and, essentially, $P=p_1=p_2=0.2$.

We may surmise, therefore, that if the patient tolerates a total observation time of four hours (two hours for each reading), the combined total counting time T is four hours, but the total observation time is six hours, since the control plus background reading need be taken only once, and it will not differ substantially from either N_1 or N_2 when the activity is low.

From Equation (1) we may calculate the signal $n_1=n_2\ (r-1)$ for these conditions:

$T=240$ minutes $n_2=371$, $p=0.2$; we obtain

$r=[(1/p\sqrt{n_2T})+1]^2=1.033$ and $n_1=12.3$ c/m.

This net counting rate corresponds to 0.03 μc. of radium gamma activity. By taking into consideration the errors in μ', d, and $k(x)$ in Equation (4) the over-all standard deviation of the gamma activity measurement at this Ra level will be close to 25 per cent.*

It should be understood that this value pertains to the absolute method discussed thus far, and that the measurable limit can be reduced by approximately one order of magnitude by recourse to relative measurements of patients placed closer to the counter. This procedure, already discussed by Evans[3] and by some of us,[6] consists in comparing the counting rate of a subject of low activity with that of another already measured by the absolute method, while both are sitting in a reproducible manner in a "standard" chair with their backs turned to the crystal. The axis of the latter is placed parallel to the vertebral column at a distance of 10 cm. and at the height of the twelfth thoracic vertebra. The reproducibility of the reading for a single patient is independent of the channel band and is close to 2 per cent. The body content is finally determined by measuring both the counting rate C_p of the patient and the net counting rate C_R of 1 μg. of Ra at 1 meter in air. The gamma-ray activity R, in μc., is then expressed by $R=C_p/C_R\times F$, where F is 7.8 ± 0.5 and 5.3 ± 0.3 for the low and high energy channels respectively, when the comparison is carried out in Room D among patients whose burden is limited to the skeleton.† This extension of the absolute method allows the measurement of the gamma-ray activity of 4×10^{-9} g. Ra equivalent with a statistical standard error of 20 per cent. If the "standardization" of the chair setup is carried out with heavily burdened patients, the remaining errors to be considered are the reproducibility error of F (6.5 per cent) and the error inherent in the skeletal distribution of the burden (10 per cent). This leads to an *over-all* average probable error:

$$0.23\times0.674\times4\times10^{-9}=\pm6\times10^{-10}\ g/\underset{\text{equivalent}}{\text{Ra}}$$

for a single observation of two hours' duration. This figure compares favorably with the figure of 2×10^{-9} g. of Ra reported in the literature,[2,12] and can be reduced by better than a factor of two by use of an 8″ Fe shield.

A twelve hour run of the background ac-

* Anticipating a standard error in the estimates of exhaled radon of ±14 per cent and the fraction of radon retained of 0.3[9], the standard deviation for a body burden of 0.1 μg. in our patients is estimated to be less than 15 per cent.

† In the case of $RaSO_4$ inhalation, F was found to be substantially higher (14 for the lower channel) soon after the accident,[6] as would be expected from the proximity of the source; this value, however, decreased to the skeletal figure after an interval of about six months. The value of F changed between 5.6 and 7.8 according to the room used and the shielding present when the lower energy channel was used. The variation with the higher channel was much less.

tivity made on three successive days was examined at thirty minute intervals in order to determine whether the stability of the instrument warranted conclusions based on simple statistical analysis. The standard deviation of the mean, computed from the deviations of the individual thirty minute samples, was found to be only 15 per cent higher than the deviation to be expected from the total number of counts obtained in the twelve hour run. We may conclude, therefore, that up to the observational limit of two hours, the stability of the instrument is satisfactory, and that the standard deviation of the background is:

$$\sqrt{\frac{N_2}{t}} = \sqrt{\frac{371}{120}} = 1.8 \text{ c/m.}$$

or 6×10^{-10} g. of Ra equivalent. It would seem, therefore, that the single crystal adopted here is capable of an ultimate sensitivity somewhat better than 10^{-9} g. of Ra reported by Reines *et al.*[10] for a "4π" scintillator. This advantage, however, will in all probability prove temporary if the stability of their setup can be brought within the potential statistical limits of their prodigious counting rates.

A few words of caution may not be entirely amiss at this point. Although the figures quoted here refer to our permanent setup (Room D, Table 1), in the interval of time covered by our measurements (1950–1954) we have had the opportunity to repeat our measurements on several patients in entirely different rooms, in each of which different amounts of lead shielding were present at different times. Despite considerable variations in the absolute value of some of the parameters (due to scattering from the surroundings), the gamma-ray activity of the body, as measured either at 1 meter on the table or in the sitting position, was always found consistent with statistical limits, provided that μ', $k(x)$, N_1, N_2, C_p, C_R and N_3 were determined under the same conditions of shielding of the room and spectral selectivity of the instrument. An illustration of the results obtained in experiments performed at an interval of two years at the Elgin State Hospital, in the same room, first with 3/16″ and then with 1/16″ Pb shielding, and with two different apparatus, is to be found in Table II of the third paper of this series.[9]

Readers interested in chronic radium toxicity will be interested to know that scintillation counters have been found eminently suited to the study of localization of small amounts of radium in the human body. In all 5 chronic radium cases that were scanned, the evidence pointed to the skeleton as the seat of the retained radon. Typical findings have been published elsewhere.[6]

Of some importance are the results of our measurements on a patient already reported in the literature by Aub *et al.*[1] This patient, who inhaled radium chloride following an accident in 1918, had been measured by Evans (Case 28, ref. 1) in 1939 and reported to have 0.3–0.4 μg. of Ra; our study revealed 0.25 ± 0.04 μg. of Ra in 1953. It is gratifying to note that these results are consistent with the accuracies involved in both measurements and with a decrease of about 20 per cent in body content calculated on the basis of Norris *et al.*[9] findings on radium retention with the Elgin cases.

SUMMARY

A sodium iodide scintillation counter apparatus has been used for the determination of the gamma-ray activity of radon retained in the body of individuals who ingested or inhaled radium twenty to thirty-five years ago. For greater sensitivity, the background radiation was reduced by means of 1/4 inch lead shielding and the signal to background ratio was improved by selection of the pulse energy band.

A method, based on original work by Evans,[3] has been evolved capable of reducing the average probable error to $\pm 6 \times 10^{-10}$ grams of radium activity in the human body with an observation period of two hours.

Confidence in the procedure has been es-

tablished by control experiments with Na^{24} in humans and Ra^{226} in dogs.

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The authors take great pleasure in acknowledging their indebtedness to Mr. J. E. Rose, Director of the Radiological Physics Division, Argonne National Laboratory, for his valuable collaboration and guidance during the course of this work.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

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Published by: Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Illinois.

Issued monthly. Annual subscription: United States, Mexico, Cuba, Central and South America, $15.00; Canada, $16.00; other countries, $17.00. Current single numbers, $1.50. Advertising rates submitted on application. Editorial office, 110 Professional Building, Detroit 1, Michigan. Office of publication, 301–327 East Lawrence Avenue, Springfield, Illinois. Information of interest to authors and readers will be found on page vi.

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Fifty-sixth Annual Meeting: Palmer House, Chicago, Illinois, September 20–23, 1955.

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Thirty-seventh Annual Meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

EDITORIALS

TUBERCULOSIS CONTROL

ATTENTION is directed to an article by Dr. David T. Smith[1] on the control and eventual elimination of tuberculosis. It exhibits such a clear conception of the present status of the problem that it seems important to bring it to the attention of the readers of the JOURNAL.

Radiologists have been in the forefront of mass surveys for case finding in tuberculosis ever since the inception of the method. In spite of doubts expressed by a few from time to time it may be stated confidently that mass chest surveys have fully justified themselves not only as an aid in tuberculosis control but as a means of educating the public, the medical profession, and the public health authorities in much that pertains to the control of this disease. However, the facts set forth in the article mentioned above indicate that we have arrived at a point where re-evaluation of the methods to be employed is in order. These facts are as follows:

1. The *overall* death rate in tuberculosis is misleading as a measure of progress in control because it does not give a true conception of the prevalence of the disease. The age and sex groups which harbor the infection must be known. A Minnesota study showed that the death rate for male infants in 1950 was only 4 and for female infants only 2 per 100,000. There was a decline in death rates from 140 in males and 150 in females at the age of twenty-five in 1920 to a low of 4 in males and 7 in females in 1950.

2. "The chief reservoir of tuberculous infection is now in males over 40 and in females over 60 years of age. This is the seed bed from which the children of this and the next generation will be infected. . . ."

3. The tuberculin test has assumed great importance. "The percentage of positive tuberculin reactors is an indirect measure of the amount of undetected open tuberculosis in the community. The presence of a positive tuberculin test pinpoints the individuals who compose the group in which new active cases will develop. There is a rough correlation between the percentage of the population with positive tuberculin reactions and the number of clinical cases and the number of deaths from tuberculosis. The key to elimination is the tuberculin test. Without the tubercle bacillus in the human body there can be no tuberculous disease. The positive tuberculin test tells us which individuals have living, virulent tubercle bacilli in their bodies and are, therefore, potential cases of the disease."

4. Whereas in past time tuberculosis was considered a disease of young adult life, now its importance is emphasized in the age group beyond fifty. "In 1950 in Wisconsin there were only 59 deaths in the population between ages 0 and 19 years but 657 in the population between the ages of 50 and 80. This gives an average rate of 1.7 deaths per 100,000 for the ages 0 to 19 and 26 per 100,000 for the ages 50 to 80."

The author makes the following recommendations:

1. It is no longer necessary to roentgenograph the entire school population to find cases of tuberculosis. All should be tuberculin tested and the positive reactors roentgenographed annually.

2. Annual roentgen examinations should be continued of all males above forty and of all females above sixty.

3. Routine roentgen examinations of all

[1] Smith, David T. The elimination of tuberculosis from the Midwestern States in the next fifty years. *Dis. of Chest*, December, 1954, *26*, 615–622.

hospital admissions, which yield from two to ten times as many active cases as mass surveys should be replaced by roentgenographing all individuals admitted over forty and only the tuberculin positive of those under forty.

4. In summary, the present program of education, case finding, treatment in sanatoriums, and rehabilitation must be continued and intensified. It should be supplemented by mass tuberculin testing. Males over forty and females over sixty and all positive tuberculin reactors should have an annual roentgen-ray examination.

The facts set forth in the above-quoted article are undoubtedly correct and the author's recommendations based upon them are so eminently sound as to leave no doubt of the wisdom of modifying the case finding program in tuberculosis in the ways recommended.

A. C. Christie, M.D.

Crescent City, Florida

Blackstone Studios New York

WILLIAM HOLMES STEWART
1868-1954

THE death of Dr. William Holmes Stewart on October 12, 1954, brought to a close a career devoted to the development of radiology.

An outstanding pioneer in diagnostic and therapeutic procedures, Dr. Stewart was for many years director of the Department of Radiology at Lenox Hill Hospital in New York City, and Clinical Professor of Radiology at Columbia University. Author of several books on radiology, he also wrote more than fifty original papers on the subject for publication in the leading medical journals.

Born in Syracuse, New York, on September 3, 1868, the son of William H. Stewart and Mary Thomas Stewart, Dr. Stewart graduated in pharmacy from the Boston School of Technology. His father was a merchant in Syracuse, and his mother, who was herself a physician, inculcated in young Stewart his zeal for the practice of medicine which distinguished his efforts throughout his life..

In 1891 Dr. Stewart received his M.D. degree from New York University, and after internships at Bellevue, Welfare, and Harlem Hospitals in New York City, he began the general practice of medicine in that city in 1893.

On October 14, 1896, he married Florence Morris of New York City, who with a son, Colonel Leslie M. Stewart, and a daughter, Mrs. Dorothee Stewart Appelbee, Washington, D. C., survives him.

After becoming interested in the field of radiology Dr. Stewart studied the subject at the University of Berlin and when he finished there in 1907, he went to the University of Vienna where he completed further studies in 1910. He then began the practice of radiology at 222 West 79th Street, New York City, an address he was to maintain all his life.

For thirty years, from 1910 to 1940, he was associated with Lenox Hill Hospital and in addition he served with Harlem, Knickerbocker, Lutheran, Gouveneur, Lebanon, and Polyclinic Hospitals. He was also consulting radiologist at Long Island College Hospital.

From 1913 to 1944 he dedicated his knowledge and his skill to the task of instructing others in the relatively unexplored field of radiology, and during the years 1937 to 1940 he pioneered the technique of filming the gastrointestinal tract on motion picture film.

In 1919 Dr. Stewart published a volume on "Pneumoperitoneum," and in 1925 he became the author of the book "Skull Fractures," a work which is still current in the Annals of Roentgenology, Volume VI. Between the years 1913 and 1944 Dr. Stewart presented scientific papers on Mastoid Disease, Skull Fractures, Lung Abscess, Peptic Ulcer, Mucosal Studies of the Gastrointestinal Tract, The Use of Opaques in the Diagnosis of Liver Disease, and he pioneered the work in the oral administration of cholecystographic contrast media. His last paper in 1944 was a treatise on Cholecystitis with Jaundice.

Dr. Stewart was a life member of the American Roentgen Ray Society and served as President of the Society in 1922. He was also past president of the American Gastroenterological Association, and a member of the American Medical Association, the American Thoracic Society, and the American College of Radiology, which group awarded him their gold medal in 1954.

Diligently active in medical organizations he was also a member of the New York State Medical Society, the New York County Medical Association, the New York Roentgen Ray Society, the Riverside Practitioners Society, and the New York Gastroenterological Society.

In World War I Dr. Stewart served with distinction as a Major in the Medical Corps of the United States Army. Throughout his life he devoted his efforts to the science of roentgenology, and his contributions to the advancement of this specialized field were noteworthy and legion. To his associates he was forever a source of inspiration and guidance, a man of unusual knowledge who was willing to impart it to others with kindness and understanding.

Eric J. Ryan, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS*

EIGHTH INTERNATIONAL CONGRESS OF RADIOLOGY

PRELIMINARY NOTICE

In accordance with the decision of the International Committee of Radiology which met in Copenhagen in July, 1953, the Eighth International Congress of Radiology will be held in Mexico City, Mexico, in 1956. The dates of the Congress will be July 22–28, 1956.

The officers for the Congress are as follows:

President—Prof. Dr. Manuel F. Madrazo, F.A.C.R.

Secretary General—Dr. José Noriega L., D.M.R.

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Radiobiology—Dr. Manuel Riebeling, F.A.C.R.

Technology—Dr. Francisco Bassols

Radiologists from all over the world will be welcome at the Congress. All national radiological societies are being asked to supply a list of their members and full details about registration for the Congress will be sent to all individual radiologists as soon as they are available.

Correspondence should be addressed to the Congress Office at Calle del Oro 15, México 7, D. F., México.

Dr. José Noriega
Secretary General

AMERICAN TRUDEAU SOCIETY

Scientific papers, panel discussions, and special lectures on pulmonary diseases will mark the fiftieth anniversary meeting of the American Trudeau Society, medical section of the National Tuberculosis Association, to be held May 23 to 25, 1955, in Milwaukee, Wisconsin. The meeting is being held in conjunction with the annual meeting of the National Tuberculosis Association. All sessions will be in the Milwaukee Auditorium.

The chemotherapy of tuberculosis and other medical aspects of treatment, the surgical management of tuberculosis and related diseases, and current research will be discussed by specialists from all sections of the country.

Panel discussions have been arranged on the home treatment of tuberculosis; the diagnosis of fungous diseases of the lungs; the prevention, epidemiology and treatment of tuberculosis in hospital personnel; the optimal time for pulmonary resection in tuberculosis; the use of radioisotopes in thoracic disease; the future of the small sanatorium; postoperative management of pulmonary resections; the use and misuse of cortisone and corticotropin in pulmonary diseases; the management of spontaneous pneumothorax; the problem of atypical acid-fast bacilli; why patients stay in hospitals; the value of pressure breathing in the treatment of pulmonary disease; diagnostic studies in diffuse pulmonary disease, and the role of routine hospital admissions roentgenograms.

OHIO STATE RADIOLOGICAL SOCIETY

The annual meeting of the Ohio State Radiological Society will be held in the Mayflower Hotel in Akron, Ohio, on May 20, 21 and 22, 1955.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Seventeenth Mid-Summer Conference of the Rocky Mountain Radiological Society will be held in Denver, Colorado, at the Shirley-Savoy Hotel on August 18, 19 and 20, 1955. Those planning to attend should obtain hotel reservations as early as possible.

AMERICAN COLLEGE OF RADIOLOGY

At the annual meeting of the American College of Radiology held in Chicago, Illinois, on February 11, 1955, the following officers were elected for the coming year: *President*, Dr. Warren W. Furey, Chicago, Illinois; *Vice President*, Dr. Bernard P. Widmann, Philadelphia, Pennsylvania; *Chairman*, Board of Chancellors, Dr. Wilbur Bailey, Los Angeles, California; *Treasurer*, Dr. Earl E. Barth (re-elected), Chicago, Illinois. The *Executive Secretary* is Mr. William C. Stronach, Chicago, and the *Director of Public Relations*, Mr. Hugh N. Jones, Chicago. Dr. Ira H. Lockwood, out-

* The list of Meetings of Radiological Societies appears in the March, 1955, issue of the Journal, and will be published in the May number.

standing radiologist, of Kansas City, Missouri, was awarded the Gold Medal of the College and this award was formally presented to Dr. Lockwood at the annual meeting of the College.

KENTUCKY RADIOLOGICAL SOCIETY

At the January, 1955, meeting of the Kentucky Radiological Society the following officers were elected: *President*, Dr. H. L. Townsend, Louisville, Kentucky; *Vice-President*, Dr. A. L. Allen, Ashland, Kentucky; *Secretary-Treasurer*, Dr. David Shapiro, 217 East Chestnut St., Louisville, Kentucky.

INDIAN CONGRESS OF RADIOLOGY

The Ninth Indian Congress of Radiology was held in Lucknow on February 11 to 14, 1955. Dr. Ralston Paterson, Director of the Christie Hospital and Holt Radium Institute, Manchester, England, was awarded the Fifth Sir Jagdish Bose Memorial Lectureship. His lecture was read at the Congress in absentia.

INDIAN RADIOLOGICAL ASSOCIATION

At a recent meeting of the Indian Radiological Association Dr. Jinabhai L. Desai of Bombay was elected President of the Association for 1955.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return or the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Shoulder Lesions. By H. F. Moseley, M.A., D.M., M.Ch. (Oxon.), F.R.C.S. (England & Canada), F.A.C.S., Hunterian Professor, Royal College of Surgeons of England; Assistant Professor of Surgery, McGill University; Associate Surgeon, Royal Victoria Hospital, Montreal, Canada. Second edition. Cloth. Price, $12.00. Pp. 329, with numerous illustrations. Paul B. Hoeber, Inc., 49 East 33rd Street, New York, New York, 1953.

This writer cannot recall undertaking a review with as much enthusiasm as in the present instance. Dr. Moseley's efforts in this recent edition can well be considered as most rewarding, and as of exceptional value to the profession and to the many sufferers from shoulder lesions.

Although this is a review, it has seemed pertinent to introduce a little historical background, especially in view of the emphasis by the book's author on his and the profession's indebtedness to the work on the same subject of Emory A. Codman (whole splendid likeness is found on a full page plate). As a quondam acquaintance and fellow citizen of the late Dr. Codman this reviewer cannot refrain from a few lines of comment on the unique contribution of the latter.

Dr. Codman did much that is not too well known which has been of incalculable value in advancing the standards of surgical science in general. But probably he will be most remembered for first bringing the painful and incapacitating lesions of the shoulder out of the limbo of ignorance, mystery or fallacy. In the 1920s his keen capacity for accurate clinical observation, his anatomical studies, and his courage in surgical investigation had brought to him such new understanding of the functional behavior of the shoulder, and of the nature among others of two particular lesions (tendinitis calcarea and injury to the "rotator cuff") that he felt impelled to pass this on in a more elaborate and detailed way than through his various articles.

The type of volume, with profuse illustrations, which he considered essential for adequate exposition, was one which publishers did not believe could be successfully marketed. Accordingly Dr. Codman in 1934 had the volume printed at his own expense, less the small part defrayed by a few dozen professional acquaintances through subscription; and this reviewer will be ever grateful for having been among the subscribers.

Dr. Moseley was fortunately one of those most stimulated by Codman's work and, assidously undertaking to carry this work forward, was able by 1945 (1st edition) to materially advance the understanding and treatment of shoulder lesions, and most importantly among others, the recognition and treatment of the bicipital syndromes. His monograph of that year, a small folio of under 200 pages, was in itself a very important and valuable contribution. Now this second edition, over 300 pages in 8 by 12 inch size, is, I believe, principally commendable for the excellence of large scale plates and figures, many in color. The text, in the main, follows that of the first edition, reworked and added to a little here and there, but with an increase in the number as well as the quality of illustrations.

This reviewer is inclined most particularly to stress the importance of Dr. Moseley's concept of the synergistic nature of the muscle function in shoulder motion—in contrast to the anatomists' attempts to ascribe a single separate aspect of movement to each motor of the shoulder girdle. Such a concept must have been in Codman's mind in his emphasis on the normal "rhythm" of shoulder girdle action. To the engineer such functioning represents the principle of "torque" forces in the production of any motion in any multi-axial articulation—in contrast to the more numerous "hinge" type joints of the body. And Moseley very properly credits Inman for correlating this principle with clinical performance.

The only point of deficiency that the reviewer can think of in Moseley's presentation is the failure to sharply clarify the separate pathological backgrounds of the "frozen shoulder." It could have been emphasized that, on the one hand, there is the inability to carry out much of any glenohumeral motion by reason entirely of pain-effects that produce a com-

bination of inhibition and spasm. Such a shoulder will seem to be "frozen"—and in one sense is so, as when anyone "freezes" at an effort which is still physically possible. Yet such a shoulder by appropriate testing can be proved free from any mechanical restriction whatever. On the other hand, there is the shoulder that is mechanically tied down by periarticular adhesions, and is frozen in the sense of a partial ankylosis.

In connection with this latter entity, the reviewer on the basis of over thirty years' experience, would take exception to the pronouncement of Moseley (and others) that there is no place in treatment for manipulative lysis of adhesions. Instead he would make the point that this is a matter of selection and timing.

The chapter on exercise re-education is again excellent, and is thought to lack only a word of caution against over-use and abuse of the pivotal clavicular articulations in the presence of major mechanical restriction of the glenohumeral action. Very proper emphasis is made by Moseley on the proposition that abduction is not a proper position of rest for the shoulder; also that the rest phase should give way to active function (starting with the "pendulum" motions) as rapidly as pain permits, even within a week or two of fractures.

The last thirty-odd pages of this second edition include remarkably clear roentgenographic reproductions of various bone lesions as well as interpretation and diagnosis by various techniques of positioning. Although of similar coverage to the first edition, the representation in this chapter has been improved in its illustrative aspects.

"Shoulder Lesions" by Moseley is not just a volume for the specialist, but is one to contribute to the knowledge of any physician.

C. W. Peabody, M.D.

Diagnosis and Localization of Brain Tumors: A Clinical and Experimental Study Employing Fluorescent and Radioactive Tracer Methods. By George E. Moore, M.D., Ph.D., Markle Scholar in Medical Science; Director, Roswell Park Memorial Institute. Cloth. Price, $10.50. Pp. 217, with 66 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

The accurate diagnosis and localization of intracranial tumors has always been, and still is, one of the major problems of neurological surgery. Not only is no method at present available completely accurate but many of them are not without risk to the life and wellbeing of the patient. Accordingly the search still goes on for safer, more satisfactory means of diagnosis. This monograph is the well written report of one such search. Basically the study here was based upon the hope that some substance could be found which might be injected into the patient and which would lodge selectively in the intracranial tumor and that this substance would be or could be made readily demonstrable. First it was found that sodium fluorescein was relatively selective for tumor tissue. Using ultraviolet light the tumor tissue stained by the fluorescein could be readily visualized at the operating table. In the Neurosurgical Clinic of the University of Minnesota, where this work was carried out by Dr. Moore in collaboration with Drs. Peyton and French, this procedure alone has been successfully used in many cases. However, what was desired was a means of demonstrating the presence and location of the tumor prior to operation. Accordingly the fluorescein was rendered radioactive, *i.e.*, a radioactive diiodofluorescein was prepared. This material was injected into the patients and the point of most intense localization within the skull was determined with a Geiger counter. Unfortunately, the method presented too many errors and too many failures to justify the use of such an expensive and complicated procedure. Unfortunately, too, the favorable reports of Askenasy which the author cites in this monograph have subsequently proved to be erroneous.

This is a well written monograph and deals with many other aspects of this vast problem. Even though this particular effort has failed, at least in part, it has also succeeded to a degree which warrants further investigations along this line. To those who would follow Dr. Moore in this research this monograph will be invaluable.

Paul C. Bucy, M.D.

Slipped Capital Femoral Epiphysis. By Armin Klein, M.D., Robert J. Joplin, M.D., John A. Reidy, M.D., and Joseph Hanelin, M.D., Massachusetts General Hospital, Boston, Massachusetts. Cloth. Price, $6.75. Pp. 144, with 230 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

The above described monograph is the one hundred and fifty-third of the American Lecture Series in Roentgen Diagnosis. Excerpts from previous publications by the authors have been used to stress the roentgenographic features of the problem. With the help of good reproductions of roentgenograms of both normal hips of all ages and good examples of the condition presented this mission is well done. The survey of their material is factual and presented in a very readable manner. The number of cases of a severe degree of deformity is not large enough to comprise a complete discussion of all methods of handling this problem.

Frank P. Walsh, M.D.

The Billroth I Gastric Resection: With Particular Reference to the Surgery of Peptic Ulcer. By Horace G. Moore, Jr., M.D., Wilmington, North Carolina; formerly Instructor in Surgery, University of Washington School of Medicine; formerly Chief Resident in Surgery, King County Hospital, Seattle; and Henry N. Harkins, M.D., Ph.D., F.A.C.S., Professor of Surgery, and Executive Officer of the Department of Surgery, University of Washington School of Medicine; Surgeon-in-Chief, King County Hospital, Seattle; formerly Associate Professor of Surgery, Johns Hopkins University School of Medicine. Cloth. Price, $7.50. Pp. 175, with 36 figures and 18 tables. Little, Brown & Company, 34 Beacon Street, Boston 6, Massachusetts, 1954.

This well organized monograph has been divided into eight chapters beginning with a concise history of gastric resection. Subsequent chapters logically develop rationale of gastric resection for peptic ulcer, the selection of patients, preoperative and postoperative care and surgical technique. The final two chapters discuss postgastrectomy syndromes and criticisms and advantages of the Billroth I operation, of which the authors are strong proponents.

Illustrations are of the highest quality, and particularly those demonstrating operative technique contribute much to this chapter by such superior artistry.

The material on history of gastric resection and bibliographical sketches of surgeons who have made important contributions to gastric surgery is very interesting and readable. The descriptions of preoperative and postoperative care, as well as the many aspects of surgical technique, have been exhaustively dealt with. The reasons for desirability of the Billroth I operation are well presented and discussed with fairness.

The monograph is well recommended to those interested in gastric surgery and would be an attractive addition to any surgical library.

Frederick A. Coller, M.D.

Medizinische Röntgentechnik. Teil II. Physikalisch-technischer Teil. Edited by Prof. Dr. med. Herbert Schoen. Cloth. Price, DM 27.00. Pp. 360, with 217 illustrations. Georg Thieme, Diemershaldenstrasse 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

This is the second part of a treatise on roentgen technique, intended for physician and technical personnel and for students in medical radiology, under the editorial supervision of Prof. Dr. Herbert Schoen of Karlsruhe. This volume (II) is the physical and technical portion dealing with the fundamentals of roentgen diagnosis and therapy as well as with apparatus and roentgen and color photographic technique, written by physicist Erich Bunde and Dr. Viktor Loeck.

The book contains some 360 pages and 217 illustrations, comprehending the detailed consideration of the above-named subjects. The work is authoritative, and obviously well done. The radiologist will find much aid in particular problems of penetration and distribution of radiation, and the measurement of dosage. The index at the close of the work covers both this volume and the previous volume on the technique of examinations in diagnostic roentgenology.

James T. Case, M.D.

A Manual of Tropical Medicine. By Thomas T. Mackie, M.D., Colonel, M.C., A.U.S. (Retired), Chairman, The American Foundation for Tropical Medicine; George W. Hunter, III, Ph.D., Colonel, M.S.C., U.S.A., Chief, Section of Parasitology-Entomology, Fourth Army Area Medical Laboratory, Brooke Army Medical Center, Fort Sam Houston, Texas; C. Brooke Worth, M.D., Field Staff Member, Division of Medicine and Public Health, The Rockefeller Foundation. Second edition. Cloth. Price. $12.00. Pp. 907, with 304 illustrations, 7 in color. W. B. Saunders Company, West Washington Square, Philadelphia 5, Pennsylvania, 1954.

This manual has been revised and rewritten with the fundamental objective of supplying basic information of current value to members of the Armed Forces Medical Corps and other physicians whose travel requires a working knowledge of various tropical diseases. Several sections have been completely rewritten and material on virus diseases has been added. Other sections, especially those dealing with rickettsial disease, relapsing fever, the dysenteries, malaria, schistosomiasis, filariasis, and laboratory techniques have been extensively revised. The rewriting of this book has been accomplished with the aid of an impressive and extensive number of collaborators.

It is strongly debatable whether this book should be referred to as a manual or even whether it should be referred to as a manual of tropical medicine. The attempt to cover so many diseases puts this work into the class of textbooks. Many of the subjects covered are not, strictly speaking, confined to or even concerned with the tropics and subtropics.

The book is well organized into sections on virus, rickettsial, spirochetal, bacterial, mycotic, protozoal, and helminthic diseases. Additional sections describe the nutritional diseases, as well as sections on laboratory diagnosis and medically important molluscs and arthropods. There are surprisingly few typographical errors, although Haverhill fever is referred to as "Haverill" fever in repeated instances.

It is regrettable that no references are given and this is especially noticeable by its absence in those sections dealing with highly debatable material of recent publication. The statement that coxackie virus infection bears no relationship to the aseptic (which is preferably called non-bacterial) meningitis syndrome or ill defined febrile syndromes in man is, of course, open to serious debate in view of recent publications on this subject.

The section on mycotic diseases is not as inclusive as one would like to see in a book on tropical medicine. No mention is made of some of the newer forms of treatment such as aureomycin or 2-hydroxy stilbamidine in the treatment of North American blastomycosis. The recommendation that 2.0 grams of oxytetracycline be given daily for ten days in the treatment of "pin-worm" infestation seems a little radical without qualifying statements as to the danger of persistent diarrhea resulting from this type of treatment. It would seem far more logical to employ less toxic and accepted methods of treatment such as diphenan or gentian violet and reserve terramycin for resistant cases. Likewise, the recommended treatment for "sprue" does not include any reference to the proven value of compound F (hydrocortisone) in this disease entity.

The authors tend to perpetuate the confusion existing regarding the use of the terms osteomalacia and osteoporosis. They use these terms interchangeably and occasionally insert the word "rickets." Osteomalacia and osteoporosis are, of course, manifestations of different underlying disease processes and should not be considered disease entities by themselves.

The section on the effects of heat, likewise, perpetuates mistaken notions about chloride loss and does not point out that the loss of sodium (not chloride) is the basic ion responsible for most of the symptoms and should constitute the basis of therapy.

The sections on medically important animals, molluscs, and arthropods is extremely interesting and fills a definite need for military and civilian physicians alike.

In spite of the above criticisms it must be pointed out that the authors have organized a difficult and comprehensive subject into a highly enjoyable and informative book. Due to the large span of diseases covered, the attempt to keep the size down to that of a manual is an almost impossible task. On the other hand, the subjects are not covered completely enough to allow this work to be used as a reference volume. It will find its best reception among those physicians who would like to obtain a general over-all working knowledge of many exotic diseases which are not stressed in medical books and are not of common enough occurrence to the average physician to allow him to keep up in his basic knowledge of these diseases.

Robert J. Bolt, M.D.

Progress in Biophysics and Biophysical Chemistry. Volume 3. Edited by J. A. V. Butler, Professor of Physical Chemistry, University of London, Chester Beatty Research Institute, Royal Cancer Hospital, London; and J. T. Randall, F. R. S., Wheatsone Professor of Physics in the University of London at King's College. Cloth. Price, $9.50. Pp. 386, with numerous illustrations. Academic Press, Inc., 125 East 23rd Street, New York 10, New York, 1953.

This is the third volume in a recently founded

series of reviews, the collective contents of which reveal in most convincing fashion the great and rapidly increasing extent to which the widely ranging problems of biological systems are being attacked from the viewpoints and with the methods of physics and physical chemistry. The articles in this volume maintain the generally high standard of scholarship that has marked the series from its outset.

The book opens with an authoritative chapter (27 pp.) on "Autoradiography," by J. Doniach, Alma Howard and S. R. Pelc; work of the last few years is emphasized. After concise sections on pertinent physical principles and techniques, the authors review, with illustrative photographs, a wide variety of biological and medical applications of autoradiography in biochemistry of the thyroid; in localization of hormones and antigen-antibody reactions; in locating radioisotopes in tumors, bones and teeth; in studies of synthesis of DNA and nucleoprotein; etc.

The next two chapters are devoted to optical methods of studying biologically important molecules. In Chapter 2 (20 pp.) entitled "Polarized Ultraviolet Microspectroscopy and Molecular Structure," W. E. Seeds discusses interpretations and methods of study of ultraviolet dichroism and reviews relevant investigations on suitable preparations of tobacco mosaic virus, nucleic acid, keratin-type proteins, hemoglobin, ribonuclease, Vitamin B_{12}, etc. Chapter 3 ("The Infra-red Spectra of Biologically Important Molecules," by R. D. B. Fraser) is brief (14 pp.) but packed with information ranging from the origin of infra-red absorption spectra to a concise summary of the spectra exhibited by proteins, nucleic acids and polysaccharides.

In a chapter on "Some Physico-Chemical Studies on Viruses" (Chap. 4, 27 pp.), R. Markham critically evaluates two of the chief techniques (centrifuge and electron microscope) and describes recent advances in the study of virus crystals (tobacco mosaic, bushy stunt, tobacco necrosis, Southern bean mosaic, turnip yellow mosaic) and of virus solutions (tobacco mosaic).

M. Errera has contributed a very informative article on "Mechanisms of Biological Action of Ultraviolet and Visible Radiations" (Chap. 5, 43 pp.). He deals systematically with studies on intact cells and on substances isolated from cells. Much attention is given to various experimental factors, such as oxygen and temperature, that modify certain radiobiological actions, and to such interesting phenomena as photosensitization and photoreactivation.

Two long chapters are devoted to certain aspects of colloids. In Chapter 6 (64 pp.) F. Booth reviews "Recent Work on the Application of the Theory of the Ionic Double Layer to Colloidal Systems." After a brief résumé of the general theory, many applications are systematically discussed, such as the stability of lyophobic colloids, coacervation, streaming potentials, electrophoresis and the electroviscous effect. Chapter 8 (68 pp.) is an equally extended and systematic treatment of "Methods of Determining the Form and Dimensions of Particles in Solution," by C. Sadron. Hydrodynamic and optical methods are concisely treated, and then many applications are described, notably to solutions of tobacco mosaic virus, of globular proteins and of DNA.

Recent advances in "Microspectrometry of Living and Fixed Cells" are described by H. G. Davies and P. M. B. Walker (Chap. 7, 42 pp.). Since the value of this technique is largely dependent on quantitative determinations, the authors wisely give special attention to sources of errors. The amount of space devoted to the ultraviolet emphasizes the utility and further promise of this spectral region in investigations of cell structure and function. However, a fair number of studies involving color reactions were available for inclusion.

The volume ends with a sixty-five page chapter on "Transport Processes and Electrical Phenomena in Ionic Membranes," by T. Teorell. The author elects not to include the "active transport" behavior of membranes. Nevertheless the chapter is crammed with information, much of it posed mathematically. Included is an account of the author's recently extended "fixed charge" theory of permeability of ionic membranes.

This volume, as well as the others in the series, should be readily accessible to anyone who wishes to keep abreast of biophysical activity in the many fields now under investigation.

Raymond E. Zirkle

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Greitz, T., and Löfstedt, S. The relationship between the third ventricle and the basilar artery. *Acta radiol.*, Aug., 1954, *42*, 85–100.

The floor of the third ventricle consists of the chiasma, the tuber cinereum with the infundibulum, the corpora mammillaria, the substantia perforata posterior and the peduncles. The substantia perforata posterior at the same time forms the roof of the cisterna interpeduncularis. In this cistern, frontally demarcated by the corpora mammillaria and tuber cinereum, the basilar artery is situated and divides into the two posterior cerebral arteries. There is thus a close relationship between the basilar bifurcation and the floor of the third ventricle which may be studied roentgenologically with the help of encephalography and angiography of the vertebral arteries.

The description of the appearance of the third ventricle in true lateral views as given in the literature is often vague, incomplete, and many times incorrect. In order to obtain such a complete filling of the third ventricle that a true representation of the floor is obtained, the patient's head must lie with the brow well raised and the central beam directed horizontally; even small deviations change the appearance of the floor of the ventricle. If the amount of air is insufficient to fill the ventricle in this position, hyperextension of the head will cause the air to lie against the floor.

On the other hand, if the ventricular system is filled in one operation and lateral views with vertically directed rays are then obtained, the result will almost without exception be incomplete filling of the third ventricle and the roentgenogram will give an incorrect conception of the anatomy.

The present conception of the roentgen anatomy of the third ventricle and its variations as presented by the authors is based on a study of material consisting of 50 ventriculograms and 50 encephalograms of adults and 30 encephalograms of children.

The floor of the third ventricle from the mouth of the aqueduct to the recessus infundibuli in adults forms a curve, convex upwards. The recessus opticus and infundibuli vary in form, size and position. Thus, they may be found in the immediate neighborhood of the upper edge of the dorsum sellae, 1 cm. or more directly above it, or entirely in front of it or behind it. From a practical point of view, it is important to note that the distance between the recessus and entrance to the sella may be a full centimeter in cases where no supracellar expanding lesion is present.

In the case of young children in the first years of life, the arch formed by the floor of the fourth ventricle, the aqueduct and the floor of the third ventricle has a sharper curve than in the adult which is due to the fact that the base of the skull is comparatively short. In consequence, a more or less acute angle is formed between the anterior and posterior halves of the floor of the third ventricle with the ventricle assuming the shape of a hook. During growth, this juvenile shape changes and the ventricle gradually takes on the adult appearance of the more flat and regular arch. The third ventricle usually obtains an adult shape as early as the age of four to five years. The anterior recessus of the third ventricle is generally to be found at a greater distance from the base of the skull in children than in adults and the basal cisterns are comparatively larger in size.

The anatomy of the basilar artery:

The cisterna interpeduncularis contains the basilar artery bifurcation, which is to be found at the level of or just above the posterior clinoid process. In many cases the position of the basilar bifurcation varies considerably in relation to the base of the skull. However, its relation to the floor of the third ventricle is less variable. This relation the authors have determined by comparing the findings in pneumography and vertebral angiography when both examinations have been made of the same patient and this has also been performed at autopsy. In cases in which the bifurcation is found high above the sella, the position of the third ventricle is also high and in cases where the basilar artery is short the third ventricle is also found in a more basal position. If the bifurcation is placed posterior to the dorsum sellae, the third ventricle will likewise be found in a more occipital position. The basilar bifurcation has in adults an almost constant location immediately behind the posterior part of the hypothalamus so that its distance from the nearest part of the third ventricle varies between 0 and 6 mm. These observations have been verified by studies in situ in more than 100 autopsies. In the case of infants, where the cisterns are comparatively voluminous, the relationship between the third ventricle and the basilar bifurcation becomes less constant. The basilar artery often projects farther into the cavity of the skull than it does in adults, as in the case of the so-called hook-shape of the third ventricle; this is probably due to the relatively short base of the skull. It is thus evident that the relationship between the third ventricle and basilar artery as well as their appearance changes considerably during the first years of life.

The authors report 5 cases in adults in which the basilar artery produced a deformity of the floor of the third ventricle. These changes were demonstrated by the use of encephalography and vertebral angiography. In all 5 cases a long and wide basilar artery caused a well defined oval circular or irregularly nodular impression in the floor of the third ventricle. The impression is so characteristic that the diagnosis should be arrived at by encephalography.

All 5 patients were over fifty years of age, males,

and had clinical and roentgenologic signs of advanced arteriosclerosis. The systolic blood pressure varied between 200 and 240 mm. of mercury. No calcification of the basal artery was visible in any of these cases. The defect produced by a long basilar artery may simulate a tumor in the hypothalamus, pons, or basal cisterns and angiography should be done to verify the diagnosis.

In summary, the authors have found that the deformation of the third ventricle by the basilar artery only occurs when the latter is enlarged. It is considered likely that this enlargment is principally caused by damage to the elastic tissue in the vessel combined with high blood pressure.—*Arthur B. Smith, M.D.*

Tolosa, Eduardo. Cysticercose cérébrale: aspects cliniques et possibilités thérapeutiques. (Cerebral cysticercosis: clinical aspects and therapeutic possibilities.) *Rev. neurol.*, 1954, *90*, 187–208.

Neurosurgical experience in cerebral cysticercosis is of relatively recent date, and the reported results of surgical intervention have varied considerably. Factors influencing the outcome of the surgical treatment are as yet unknown. For this reason the author decided to report his experience in cerebral cysticercosis and on the therapeutic measures which are available for this disease. His report originates in Barcelona, Spain. The list of cases operated on since 1942 contains 15 cases of cerebral cysticercosis verified by operation. They are divided into:

1. Disseminated cysticercosis of the cerebral hemispheres; 3 cases.
2. Racemose cysticercosis of the base of the cerebrum; 7 cases.
3. Localized cysticercosis of the cerebral hemispheres; 1 case.
4. Localized cysticercosis of the fourth ventricle; 4 cases.

Individual cases of these four groups are presented in detail with accompanying reproductions of ventriculograms, photomicrographs and photographs of anatomical specimens.

In Group 1 the operations with decompression are well tolerated and prevent for a long time intracranial hypertension. The operative mortality is nil.

In Group 2 the prognosis is extremely poor. Although the operation is generally well tolerated the hypertension recurs quickly, and patients die within a short time. The operative mortality is 16 per cent.

In Group 3—only one case—the immediate result is satisfactory. The patient's condition remains satisfactory after two years.

In Group 4 the operative mortality is about 50 per cent. Considering that the lesion is often of the solitary type, the outlook would seem good for a greater percentage of definitive cures.—*Hans Lewin, M.D.*

St. John, Elmer G. Asymmetrical widening of the coronal suture secondary to an infected subdural hematoma. *Radiology*, Aug., 1954, *63*, 246–247.

The author presents a case of unilateral separation of the coronal suture secondary to chronic, infected, subdural hematoma.

The patient, a white male, seven months old, was hospitalized with sudden onset of vomiting and fever. No history of trauma was recorded. The findings pointed to a subdural hematoma on the left side, with evidence of infection. Skull roentgenograms on admission revealed marked separation of the left half of the coronal suture, along with some widening of the sagittal suture. There was bulging and thinning of the cortex on the frontal view at the site of the lesion. These findings were confirmed at craniotomy, and a subdural abscess was found beneath the left temporoparietal suture. Six weeks postoperatively an encephalogram showed displacement of the ventricular system to the right and depression of the roof of the left lateral ventricle.—*Michael J. Healy, M.D.*

Notter, G. Chorioidea- und Irismelanome; Bericht über 70 Patienten. (Melanomas of the choroid and iris; report on 70 patients.) *Strahlentherapie*, 1954, *94*, 354–366.

From 1921–1952, 70 patients with malignant melanomas of the inner eye were treated at the Radiumhemmet in Stockholm. Histopathologic examinations were made in 59 patients; in the remainder the diagnosis rested on clinical grounds only. In 56 patients the malanoma was in the choroid; in 7 in the iris; and in the remaining 7 the primary site was uncertain but presumed to be the choroid. Forty-five patients (72 per cent) died of melanomatous metastasis during postoperative observation periods that varied from four months to twenty-four years. Six patients died of intercurrent conditions after an average observation period of thirteen years. Eleven patients (19 per cent) are alive and symptom-free after observation periods that average eleven years.

Penetration of the sclera by the melanoma worsens the prognosis; on the average, life expectancy was decreased by 1½ years.

Enucleation of the eyeball constitutes adequate treatment unless the sclera is perforated, in which event exenteration of the orbit is necessary. Operation should follow immediately on establishment of the diagnosis. Radiation therapy has no more than a palliative role.

Melanomas of the iris have a better prognosis. All

7 patients with melanomas of the iris have remained alive and symptom-free for observation periods that average 8½ years. Of the 7 cases, 6 underwent enucleation and 1, local excision of the tumor.

No prepubertal melanomas occurred.—*Henry G. Moehring, M.D.*

Neck and Chest

Calderon, Roberto, Ceballos, Jorge, and McGraw, John P. Tomographic aspect of paralysis of the vocal cords. *Radiology*, Sept., 1954, *63*, 407–410.

Paralysis of the vocal cords can be diagnosed easily by direct or indirect laryngoscopy, but additional valuable information can be obtained by laminagraphic study. Laminagraphy may settle the diagnosis whenever laryngoscopy is unsatisfactory or impossible. Lateral roentgenograms of the neck should be taken routinely before laminagrams are made.

The following observations were made on laminagraphic studies of laryngeal paralysis:

(1) The paralyzed cord is elevated.
(2) There is better visualization of the ventricle, which appears wider on the paralyzed side. This is seen with the Valsalva maneuver and during phonation.
(3) The arytenoid and base of the aryepiglottic fold hang toward the normal side.
(4) The paralyzed cord is in the midline or slightly retracted. During phonation the normal cord moves across to come in apposition with the paralyzed one.
(5) The bottom of the pyriform sinus is higher on the side of the paralysis.
(6) There is fullness of the subglottic area on the paralyzed side.

The swallowing mechanism of the larynx is preserved in paralysis of the vocal cords. When barium is seen entering the larynx in cases of cord paralysis, a severe involvement of the whole vagus nerve, with or without paralysis of the glossopharyngeal nerve, should be suspected.—*A. W. Sommer, M.D.*

Fletcher, Gilbert H., Old, Jacob W., and Loquvam, George S. A topographic approach to the roentgenologic and pathologic examination of the laryngopharyngeal tumors. *Radiology*, Sept., 1954, *63*, 361–380.

The authors present a series of 9 cases of primary laryngopharyngeal tumors to illustrate the principles of roentgenologic evaluation of tumor location and extension. Lateral soft-tissue films and laminagraphic studies are advocated as essential for a complete examination of any laryngopharyngeal tumor. The laminagram is particularly valuable as a supplement to the classical methods of clinical examination.

Roentgen studies permit assessment of the degree of extension in the following regions:

(1) Ulceration of the epiglottis and invasion of the pre-epiglottic fossa (lateral soft tissue film).
(2) Destruction of the thyroid cartilage anteriorly (lateral soft tissue film) or of the ala (laminagram).
(3) Subglottic extension of tumor (laminagram).

Laminagraphic histologic studies were done to determine the accuracy and limitations of the roentgenologic evaluation of tumor location and extension within the larynx. In each of the 9 reported cases, large sections were prepared from the whole excised larynx and the tissues were subjected to a thorough histologic study. In these large sections extensions of tumor to surface margins of excision often became apparent.

The authors classify laryngopharyngeal tumors, according to anatomic site of origin, as follows:

Three levels of origin are considered within the larynx itself:

(1) Supraglottic: ventricle, ventricular band (false cord), and laryngeal surface of infrahyoid epiglottis.
(2) Glottic: superior surface or free margin or true vocal cords.
(3) Subglottic: inferior surface of true cord or trachea.

Two levels above the supraglottic are distinguished as separate loci, due to definite differences in clinical course and response to therapy:

(1) Epilaryngeal: suprahyoid epiglottis and free margin of the aryepiglottic fold, *i.e.*, "brim" of the laryngeal vestibule.
(2) Piriform sinus: bottom of sinus and sinus surface of aryepiglottic fold.—*A. W. Sommer, M.D.*

Bourgeois, Robert, Beau, H., and Gérard, P.-L. Exploration radiologique du rhinopharynx par des niveaux progressifs de lipiodol. (Roentgenological examination of the nasopharynx with progressive levels of lipiodol.) *Ann. d'oto-laryng.*, 1954, *71*, 560–568.

The authors describe a new method of roentgenologic examination of the nasopharynx for the detection and delineation of tumors of the posterior nasopharynx, especially in the region of the orifice of the eustachian tube. They claim their method will improve the diagnostic results of rhinoscopy and rhinopharyngoscopy. They describe their technique as follows: The patient is placed in supine position on the roentgenographic table with the head in slight hyperextension, so that the Virchow plane extending from the external acoustic meatus to the infraorbital margin is at an angle of 45° with the hori-

zontal plane. The film containing cassette is placed on the horizontal Bucky diaphragm, and the central beam is directed vertically from the tube to the outer acoustic meatus. A second roentgenogram is taken at an angle of 90° with a vertical cassette and a horizontal central beam.

Without anesthesia a small amount of lipiodol is injected into the right and left nostrils. A few minutes after injection the first pair of roentgenograms is made. After injecting additional small amounts of lipiodol five pairs of roentgenograms are taken with five progressive levels or increments of lipiodol.

By this method a pool of lipiodol is formed on the posterior wall of the nasopharynx in which any tumor mass shows as a filling defect: on the horizontal film en face, on the vertical film in profile. The examination with progressive increments of lipiodol helps depict any tumor.

Three cases of tumors of the posterior nasopharynx are described in the article. Reproductions of the roentgenograms of 2 cases and an explanatory diagram of the second case accompany the case reports. —*Hans Lewin, M.D.*

Ingleby, Helen, and Gershon-Cohen, J. Adenosis of the female breast. *Surg., Gynec. & Obst.*, Aug., 1954, *99*, 199–206.

Adenosis is a common condition consisting of unencapsulated parenchymatous hyperplasia in the breast. Foci may be single or multiple and are usually bilateral.

Except for pain and disappearance of tumors, the symptomatology is not unusual. Lesions occurred in patients aged from twenty-one to forty-nine years.

Roentgen examination may help in doubtful cases. Discrete ground-glass opacities are seen with irregular outlines. Some lesions are partially outlined by sharp margins resembling incompletely encapsulated fibroadenomas. The lesions are usually bilateral and vary in size and shape. Cysts and fibroadenomas are distinguished from adenosis by their smooth sharp margins. Trabeculae merge with areas of adenosis, but are displaced by cysts and fibroadenomas.

The authors classify these lesions into four groups microscopically. Type A shows well formed lobules with hyperplasia of epithelial and myo-epithelial cells. Type B has lobules consisting of dilated ductules with hyperplasia of myo-epithelium. Type C is similar to Type B except that myo-epithelial cells are scanty or absent. Type D is the sclerosing type.

The Type C form is of special interest for it may be precancerous. Adenosis may disappear, undergo fibrosis or lead to cyst formations.—*George A. Miller, M.D.*

Tuddenham, William J., Gibbons, John F., Hale, John, and Pendergrass, Eugene P. Supervoltage and multiple simultaneous roentgenography—new technics for roentgen examination of the chest. *Radiology*, Aug., 1954, *63*, 184–191.

New techniques are being studied in an attempt to obtain better visualization of the mediastinum on survey chest roentgenograms. One technique, called multiple simultaneous roentgenography, involves the use of a cassette containing two pairs of fluorescent intensifying screens. One pair is coated with a "faster" phosphor than the other. By exposing one sheet of film between the two "fast" screens and simultaneously exposing another sheet of film between the two "slow" screens, it is possible to produce two roentgenograms of different densities with a single exposure. With use of proper roentgenographic factors the film between the "fast" screens will record the grosser structures of the mediastinum, while the other film will record the lung field details. Cassettes for using this technique still require technical refinement before they will be satisfactory for general usage.

The other new technique being investigated is that using supervoltage roentgenography. Since the mass absorption coefficient of bone approaches that of fat and muscle with radiation generated between 200 kv. and 5,000 kv. it was thought that the detection of soft tissue lesions overlying skeletal structures would be more likely if this supervoltage radiation were used. Consequently experiments using 2,000 kv. radiation for chest roentgenograms were performed.

With this technique mediastinal structures, including the larynx, trachea, main stem bronchi, aorta, and the mediastinal portions of the lungs are consistently demonstrated to much better advantage than on conventional studies. Abnormalities of the tracheobronchial tree are better shown.

The authors feel that clinically this supervoltage technique is at present only a useful adjunct to conventional methods, and that before it can become useful for survey studies, further investigation will be necessary.

Earlier detection of bronchogenic carcinoma and other chest lesions in the roentgenographic screening of large population groups is the goal of these newer techniques.—*Donald N. Dysart, M.D.*

Steiner, Robert E. The radiology of congenital heart disease. *Med. Illustrated*, Sept., 1954, *8*, 577–586.

A general survey of some congenital cardiac conditions is given. The author stresses, in his introductory remarks, the differential value of the roentgenographic and roentgenoscopic appearances of the main and peripheral pulmonary vessels.

A useful classification of congenital heart disease is appended, dividing the conditions into those without an intracardiac shunt, and those with a shunt, the majority of which produce cyanosis.

Some of the features discussed include:

1. Coarctation of the aorta: Visualization of the coarcted segment on the posteroanterior roentgenogram as well as on angiocardiography or retrograde aortography; the impression of the poststenotic dilatation of the barium-filled esophagus; rib notching; enlarged left ventricle; hyperdynamic ascending aorta.

2. Pulmonary stenosis: Right ventricular enlargement; poststenotic dilatation of pulmonary trunk (common in valvular stenosis, uncommon in infundibular type); inadequate peripheral vascular filling, depending on degree of stenosis; angiocardiographic demonstration.

3. Patent ductus arteriosus: Prominent pulmonary artery and overfilled peripheral vessels; intrinsic arterial pulsations as judged by density variations in relation to cardiac cycle; left auricular enlargement; aortography is of value, to exclude, for instance, associated coarctation of the aorta.

4. Anomalies of aortic arch and great vessels: Examination by barium swallow and laminagraphy is useful.

5. Anomalous pulmonary venous drainage and persistent left superior vena cava: Laminagraphy and angiocardiography are used.

6. Atrioseptal defect: The heart and lungs may appear normal, or there may be enlargement of the right auricle and right ventricle and prominence of the pulmonary trunk; there may be overfilled pulmonary vessels with intrinsic pulsations; angiocardiography is of little value.

7. Lutembacher's complex: In addition to the findings as seen in atrioseptal defect, there is also some enlargement of the left atrium, and the intrinsic pulsations are vigorous even in the peripheral pulmonary vessels. The pulmonary trunk may be of aneurysmal size.

8. Simple ventricular septal defect: The chest roentgenogram may be normal in a small defect. If the defect is larger, there may be present: right ventricular enlargement; dilatation of the pulmonary artery; overfilling of the peripheral vessels; intrinsic pulsation. Angiocardiography may be useful if a right-to-left shunt has developed.

9. Tetralogy of Fallot: There is a right ventricular enlargement; the pulmonary arteries are reduced in size and the peripheral vascular filling of the lungs is inadequate; there is an abnormally placed aortic arch in 20 per cent. Routine chest roentgenogram may be normal in mild cases. The pulmonary artery may be so small that the lungs are largely supplied by bronchial arteries. On the other hand, a main branch of the pulmonary trunk may be absent. Angiocardiography may therefore be valuable.

10. Tricuspid atresia: the right ventricle is small; the left atrium and left ventricle may be enlarged; the lung vascular markings may be reduced, and may appear abnormal owing to bronchial arteries supplying the lungs. Angiocardiography characteristically shows absence of right ventricular filling, and is valuable in demonstrating the way in which the lungs are supplied.

11. Transposition of the great vessels: The use of angiocardiography is stressed.

12. Persistent truncus arteriosus: Angiocardiography is very valuable.—*André Bruwer, M.B., Ch.B.*

Margulis, Alexander R., Figley, Melvin M., and Stern, Aaron M. Unusual roentgen manifestations of patent ductus arteriosus. *Radiology*, Sept., 1954, *63*, 334–345.

Usually the diagnosis of patent ductus arteriosus can be made on physical examination, but roentgen investigation can often supply helpful contributory information.

If cardiac catheterization is done, the diagnosis is suggested by a significant increase in the oxygen content of the blood in the pulmonary artery, over that in the right ventricle. If the examiner is able to pass the catheter through the ductus into the descending aorta, the diagnosis is proved, and in patients with reversed flow through the ductus, this is necessary for the diagnosis to be made, with this procedure.

Except in special angiographic studies, the roentgen examination is seldom diagnostic. The findings are: slight to moderate enlargement of the pulmonary artery, left atrium, and left ventricle; an increase in caliber of peripheral pulmonary vessels, which may show hilar dance. The heart is seldom greatly enlarged, unless congestive failure is present.

The findings with angiocardiography are usually nonspecific, and although thoracic aortography is of more value, it also is employed only in atypical cases, because of the hazards involved.

The findings in 7 patients with unusual roentgen features in this condition are presented, demonstrating:

1. Pulmonary infarction due to bacterial endarteritis—demonstrating the greater frequency of pulmonary infarction than systemic, because the vegetations locate on the pulmonary artery side of the ductus.

2. Calcification at the aortic origin of the ductus.

3. Dilatation of the descending aorta at the origin of the ductus—the "infundibulum of the patent ductus arteriosus."

4. Angiocardiographic "jet defect" in the pulmonary artery—a transient defect seen during the opacification of the pulmonary artery, due to a jet of nonopaque blood from the aorta.

5. Reversed flow through the ductus, due to pulmonary hypertension, and demonstrable by angiocardiography. Pulmonary hypertension may be the cause of many atypical cases, and ductus ligation can be detrimental, and even fatal, in the presence of long standing pulmonary hypertension with irreversible pulmonary vascular disease.

6. Unusual heart shape in infancy—does not ex-

clude a patent ductus arteriosus.

7. Aneurysm of the pulmonary artery—it is pointed out that 20 per cent of patients with this have an associated patent ductus arteriosus.

Because of the frequency of patent ductus arteriosus, its complications, and the potential irreversibility of cardiac and pulmonary changes if surgical repair is too long delayed, it is imperative that the diagnosis be made as early as possible. Awareness of the unusual as well as the more common findings will enable the roentgenologist to be of greater service in this effort.—*C. L. Stevenson, M.D.*

Jones, Malcolm D., and Steinbach, Howard L. Coarctation of the aorta with regression of rib notching following surgery; report of a case. *Radiology*, Aug., 1954, *63*, 248–250.

It is well known that dilatation and tortuosity of the vessels forming the collateral circulation in coarctation of the aorta frequently cause rib notching. Since the advent of improved surgical techniques, operation for correction of the coarctation has become increasingly common. Consequently, opportunity is now available to follow rib notching and other diagnostic signs in the postoperative stages.

The authors present the case of a fourteen year old boy whose postoperative roentgenographic examinations reveal improvement in the rib notching following resection of the coarcted area and end-to-end anastomosis of the aorta. It is suggested that this improvement is the result of the return of blood flow to the normal channel so that there is no longer dependence upon the collaterals for distal aortic blood supply, as well as the potential for regeneration of bone in this age group.—*A. Ralph Watson, M.D.*

Smith, Philip W., Wilson, Charles W., Gregg, Hugh A., and Klassen, Karl P. Cardioangiography. *J. Thoracic Surg.*, Sept., 1954, *28*, 273–280.

The authors give their experience with 75 ventricular punctures in 18 dogs for cardioangiography. Dangers of the procedure, as assessed by these experiments, ane intramyocardial injection of the contrast medium (70 per cent diodrast), coronary vessel laceration, ventricular fibrillation, perforation of other viscus and cerebral or renal damage from the contrast medium. Measures suggested to minimize these dangers were the use of short beveled needles to decrease the possibility of intramyocardial injection, puncture of the diaphragmatic surface of the heart to avoid the larger coronary arteries, rapid injection (2 seconds) of the contrast medium to reduce the time of coronary transit and ischemia. The amount of contrast medium suggested is 20 cc. of 70 per cent diodrast. Nasal oxygen is used throughout the procedure.

The procedure was carried out in 6 human cases without mortality. One case had ventricular fibrillation necessitating cardiac massage which was successful.

The authors suggest that this method delineates the ventricular system, valves and septal defects better than previous methods.—*Paul C. Olfelt, M.D.*

Eberl, J. Zur röntgenologischen Darstellung und Analyse des Diaphragmas und Foramen oesophagicum. (Roentgenologic demonstration and analysis of the diaphragm and of the esophageal foramen.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1954, *81*, 270–275.

The exact localization of the foramen (hiatus) is important for the decision whether a certain object is above or below the diaphragm. This is rather difficult, even with the help of barium in the esophagus and stomach. Critical analysis of routine roentgenograms will lead to proper orientation, though at first they may convey a wrong impression.

One may be tempted to assume that the hiatus is located at the point where the esophagus crosses the contour of the diaphragm. But in the great majority of cases the hiatus is either higher or lower, depending on whether the dome or the descending portion of the diaphragm is depicted. The hiatus lies not much below and behind the dome.

In prone position the anterior portion of the diaphragm is displaced upward and the remainder is further removed from the posterior thoracic wall than in the recumbent and erect positions. The recumbent position is nearest the ideal demonstration of the hiatus. In the prone view a portion of the stomach may simulate a position above the diaphragm in obese subjects. In these cases the stomach has an upward convex course, crossing the esophagus at an almost right angle. Thus, the illusion of a hernia or volvulus is created. This phenomenon is explained by the fact that in prone position the anterior portion of the diaphragm is displaced upward and that the stomach, when pushed upward, crowds itself as closely as possible against the lower surface of the diaphragm.—*S. W. Westing, M.D.*

Shaw, K. M., Collins, D. M., and Macnamara, J. The role of bronchography in pulmonary tuberculosis. *Am. Rev. Tuberc.*, Aug., 1954, *70*, 274–284.

The importance of bronchography in patients with pulmonary tuberculosis under assessment for surgical treatment is discussed. One hundred patients were briefly reviewed by the authors to determine the limitations and dangers of bronchography and to reach a conclusion regarding its usefulness with reference to surgical treatment. Dionosil was the contrast medium used except for 3 cases where sulfadiazine suspended in iodized oil was substituted. Of

the 100 patients, 72 suffered no ill effects; 25 had transient fever; 2 had fever with bronchospasm and influenza-like symptoms; 1 had transient atelectasis; and further spread of the disease occurred in only one. In general, the patients in whom these complications were present were those with widespread tuberculosis. On these patients bronchography should only be used if essential. The authors summarize the value of this procedure as follows:

1. Anatomical localization. Bronchography was successful in localizing the disease on a segmental basis when other roentgenographic techniques failed to do so.

2. Demonstration of unsuspected areas of bronchial damage.

3. Demonstration of healthy segments. A large number of cases showed that anteriorly placed segments escaped involvement. In upper lobe disease the finding of this normal segment made the surgeons feel justified in conserving a large volume of healthy lung.—*P. B. Parsons, M.D.*

Birkelo, Carl C., Martineau, Perry C., and Voelz, Frank H. The radiologist's responsibility in pulmonary resection. *Radiology*, Sept., 1954, *63*, 325–333.

The authors emphasize the value of correlation of roentgenological, surgical, and pathological findings in cases of pulmonary resection of tuberculous lesions.

The objectives, the form, and results of treatment are discussed.

The roles of the clinician, the surgeon and the pathologist are described and related to the role of the radiologist. The radiologist must detect cavities on the chest roentgenograms and decide whether they are closing under clinical management or whether surgery is indicated. The radiologist must decide whether nodular lesions are resolving or whether they should be surgically resected. Scar tissue characterized by linear densities in the absence of nodules should be recognized as usually being free from active disease.

By presenting to the surgical staff a complete description and localization of lesions, the radiologist aids the surgeon in planning his attack more accurately before entering the thorax.—*E. E. Seedorf, M.D.*

Dassel, Paul M., and Kirsh, Israel E. Nontraumatic pneumopericardium and pyopneumopericardium; report of two cases. *Radiology*, Sept., 1954, *63*, 346–352.

Nontraumatic pneumopericardium is a rather uncommon condition, but the diagnostic features are specific. The diagnosis should be considered when there is a history of sudden onset of precordial or upper abdominal pain, dyspnea, cyanosis, and fainting. On physical examination a high pitched metallic splashing sound is noted with each heart beat. The pulse rate is increased and the temperature elevated. A poorly defined area of hyperresonance may be found. Electrocardiographic changes are those of pericarditis. Roentgenologically, the parietal pericardium is visible as a relatively thin, bulging, curvilinear band of increased density separated from the heart by a radiolucent area of varying width, depending on the amount of air present. The thickness of the parietal pericardium is dependent upon the associated inflammation and edema. Fluoroscopically, the heart pulsation is vigorous, and fluid, if present in the pericardial sac, may be seen to "quiver" with cardiac motion.

Various mechanisms have been described for the production of nontraumatic pneumopericardium. Regardless of the underlying cause, infection commonly occurs, so that eventually pyopneumopericardium is present.

The authors report one case of pyopneumopericardium which occurred secondarily to perforation of a gastric ulcer, and one case of pneumopericardium following perforation of a carcinoma of the esophagus.—*A. Ralph Watson, M.D.*

Ellis, F. Henry, Jr., and Bruwer, André. The roentgenographic image of the azygos vein: a possible source of diagnostic confusion. *Proc. Staff Meet., Mayo Clin.*, Sept. 1, 1954, *29*, 508–513.

It is important to differentiate between the shadow of the azygos vein, and other unusual mediastinal shadows, which may be of more serious significance. It is seen in 6 to 15 per cent of routine posteroanterior chest studies. It casts an oval or spindle-shaped shadow, larger in its lower pole and of the same density as the aorta. The trachea is medial to it and the right upper lobe bronchus inferior. Superiorly, it is continuous with the shadow of the superior vena cava. Laminagraphy and fluoroscopy should establish the diagnosis.—*George L. Sackett, Jr., M.D.*

Maier, Herbert C. Absence or hypoplasia of a pulmonary artery with anomalous systemic arteries to the lung. *J. Thoracic Surg.*, Aug., 1954, *28*, 145–162.

This article discusses the clinical and roentgenologic features of absence or hypoplasia of a pulmonary artery not associated with tetralogy of Fallot or other major congenital cardiac lesions. While some patients with this anomaly have histories of repeated upper respiratory infections, many are free of symptoms and the routine chest roentgenogram has led to the diagnosis. The chief roentgen finding is an absence or decrease of the normal hilar vascular shadows on the involved side with enlargement on the opposite side. This finding is much more easily demonstrated on the right than on the left because

of the overlying heart on the left. Another important change is some reduction in the volume of the abnormal lung with a marked loss of respiratory function. With the latter finding, there is an associated elevation of the diaphragm on the involved side and shift of the mediastinum to that side. An increase in the functional communication between the pulmonary and bronchial vascular systems has been found. Angiograms, in addition to demonstrating an absence of a pulmonary artery, often show enlarged bronchial arteries. Three cases of the anomaly are described. No definite recommendations as to therapy have been made as yet.

Two cases of hypoplastic unilobar right lung with a small pulmonary artery and several enlarged systemic arteries to that lung are also described. These patients were quite dyspneic, presumably from the pulmonary engorgement and increased pulmonary vascular pressure secondary to the connecting systemic arteries.—*Paul C. Olfelt, M.D.*

Davis, Edgar W., Hampton, Aubrey O., Bickham, Charles E., and Winship, Theodore. Lipoid pneumonia simulating tumor. *J. Thoracic Surg.*, Aug., 1954, *28*, 212–219.

The authors believe that the clinical, roentgenologic, and gross pathologic findings in lipoid pneumonia and pulmonary cancer are usually so similar that only histopathologic study will differentiate them. Six cases are described and while this series is not large, the symptoms and findings are fairly characteristic of larger groups referred to in the article.

Half of the cases sought medical advice because of pulmonary symptoms. Chronic cough was most common; other symptoms were chest pain, dyspnea and hemoptysis. In all but one case, a history of oil ingestion was obtained after the oil had been found in the resected lung.

In general, the roentgen features are those of fibrosis and consolidation. The disease usually remains unchanged for years but in one of the cases described, the lesion enlarged slowly. The fibrosis is usually in the form of fine linear or nodular densities which may or may not reduce the size of the lobe. An apparent area of consolidation produced by this disease can often be shown to contain air by good Bucky technique which would rule out a solid tumor or complete collapse. The lower lobes, especially the right, are most commonly involved.

The finding of oil within phagocytes in the patient's sputum may be helpful in the diagnosis.

Lipoid pneumonia was not recognized in any of the reported cases at the operating table because of the close similarity to carcinoma. All the pulmonary lesions were firm and rubbery and in one case there was dimpling of the pleura over the mass. The hilar and mediastinal lymph nodes were greatly enlarged in 2 cases.—*Paul C. Olfelt, M.D.*

Abdomen

Varela-López, J. A., and Zubiaurre, L. El síndrome cístico. (The cystic syndrome.) *An. Fac. de med. de Montevideo*, Jan.–Feb., 1954, *39*, 97–128.

The cystic syndrome indicates disease produced by incomplete or intermittent complete obstruction of the region of the cystic duct. The authors present results of study of a group of these patients with duodenal drainage and cholecystography. Incomplete obstruction of the cystic duct may be produced by a stone in the common duct or by spasm of the cystic duct, with or without stones in the gallbladder. Anomalies or inflammatory changes may result in angulation or partial obstruction of the cystic duct. Distention of the gallbladder combined with slow duodenal drainage is of importance. Transitory reflex spasm of the sphincter of Oddi may be secondary to disorder of the cystic duct or to disease of the duodenum.—*Charles M. Nice, Jr., M.D.*

Larghero, P., Astiazarán, M., and Gorlero Armas, A. Hemobilia traumática; consideraciones sobre la autólisis hepática aséptica y bacteriana. (Traumatic hemobilia; considerations regarding aseptic and bacterial liver autolysis.) *An. Fac. de med. de Montevideo*, March–April, 1954, *39*, 187–206.

Bleeding from the liver is caused by disease in the liver, hepatic ducts or is the result of trauma. In traumatic bleeding there is characteristically a delay in the appearance of hemorrhage for two or three weeks following the injury and recurrences of the bleeding at intervals varying from days to months. The mechanism is an autolysis of the liver parenchyma at the site of the injury with ulceration of the vessels and biliary ducts. Coincident infections are extremely rare. A case is presented in which a trauma to the liver with characteristic findings was followed by infection.

The patient, a male, age thirty-eight, suffered a severe contusion to the thorax and abdomen. Nineteen days later he showed recurrent hemorrhage from the liver accompanied by biliary colic which was shown to be caused by blood clots in the common duct. The bile was first aseptic but subsequently with the development of hepatomegaly bacteria were found in the bile. Recovery followed promptly when it was found that bacteria were sensitive to chloromycetin.—*Murray M. Friedman, M.D.*

Espinosa Rodriguez, Lüis. Colangiografía. Biligrafina en la visualización de las vías biliares. (Cholangiography. Biligrafin in the visualization of the biliary tract; preliminary report.) *Arch. cubanos cancerol.*, July–Sept., 1954, *13*, 274–283.

The advantages of a nonsurgical method for visualizing the biliary tree are obvious, especially in cases in which there is a recurrence of symptoms similar to those found prior to cholecystectomy and where residual calculi are suspected. Satisfactory visualization of the intra- and extrahepatic bile ducts can be obtained in films exposed from twenty to thirty minutes after the injection of biligrafin. The gallbladder is visualized two hours later.

Improved visualization of the hepatic ducts can be obtained by the administration of the drug by mouth in tablet form twelve hours before the intravenous injection is given. Fifty cases were examined in this manner without serious reaction.—*Murray M. Friedman, M.D.*

Schmidt, H., and Guttmann, E. Die Verzweigung der grossen intrahepatischen Gallenwege in der röntgenologischen Darstellung (Analyse des Cholangiogramms). (Roentgenologic demonstration of the hepatic ducts and their ramifications; analysis of cholangiogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1954, *81*, 283–296.

The main hepatic duct divides into a right and left branch. The right branch in turn divides into a dorsal and ventral branch. The dorsal branch drains the dorsocaudal segment of the right lobe, the ventral branch the intermediary and the ventrocranial segments. The left branch forms a medial branch draining the quadrate lobe and supplies a branch for the dorsolateral and ventrolateral segments. Numerous variations of this arrangement are observed.

The various above mentioned branches are demonstrated on a cholangiogram obtained by injection of an autopsy specimen and on cholangiograms obtained in vivo by intravenous injection of cholografin.

This is an anatomical and roentgenographic study reflecting the increased interest in the anatomy of the intrahepatic biliary ducts brought about by introduction of intravenous cholangiography.—*Karol E. Matzinger, M.D.*

Rack, Frank J., and Glazer, Norman. A suggestive x-ray sign of strangulation in intestinal obstruction. *A.M.A. Arch. Surg.*, Aug., 1950, *69*, 233–241.

Intestinal strangulation is a surgical emergency that may be difficult to recognize. Roentgenographically, the typical appearance of simple obstruction is not usually present, but the authors noted other signs which might be of aid in diagnosing strangulation.

The presence, in the supine roentgenogram, of a definite localized mass, shadow, or haze, with a ground-glass appearance, suggests the mass of necrotic bowel. This may have a definite polycyclic or scalloped border.

The ground-glass appearance is felt to be due to the release of fluid in the involved segment of the bowel, both into the lumen and into the peritoneal cavity, with subsequent loss of demarcation between the loops.

This mass must be differentiated from other abdominal organs, tumors, abscesses, etc.—*George L. Sackett, Jr., M.D.*

Deeb, Paul H., and Stilson, Walter L. Roentgenologic manifestations of lymphosarcoma of the small bowel. *Radiology*, Aug., 1954, *63*, 235–240.

The incidence of multicentric and unicentric lymphosarcoma is discussed and the increasing frequency of involvement of the intestinal tract is emphasized.

Four cases with intestinal involvement are reported. The characteristic findings of lymphosarcoma disappeared following roentgen therapy in 2 cases.

The roentgen appearance in lymphosarcoma of the bowel is similar to that of regional enteritic, nontropical sprue, and motor dysfunction. The presence of multiple marginal nodular defects helps to differentiate lymphosarcoma from these other lesions. In intestinal lymphosarcoma there is usually destruction and obliteration of the mucous membrane pattern, "stiffness" of the walls and absence of peristalsis. There are often crescentric indentations due to small infiltrates, and in some cases, the picture is only that of intestinal obstruction.—*E. E. Seedorf, M.D.*

Lasser, Elliott C., and Rigler, Leo G. Observations on the structure and function of the ileocecal valve. *Radiology*, Aug., 1954, *63*, 176–183.

The anatomy of the ileocecal valve is reviewed. It is composed of an upper and lower lip which are capable of both sphincteric and valvular action. It is concluded that the ileocecal valve should not be regarded as categorically "competent" or "incompetent." Each valve undergoes successive states of competency and incompetency as increasing tension is placed upon the cecum.

The authors state that it does not seem necessary in all cases to postulate incompetency of the ileocecal valve when distended small bowel is seen in the presence of colonic obstruction.—*E. E. Seedorf, M.D.*

Katz, Isadore, and Arcomano, Joseph. Roentgen findings in a case of perforation of the cecum by a bone. *Radiology*, Sept., 1954, *63*, 411–414.

A case is reported in which roentgenograms of the

abdomen were found on retrospect to demonstrate a bone which had perforated the cecum and produced an abdominal mass. Roentgenograms of a resected segment of the terminal ileum and a portion of the ascending colon revealed the linear bone 4 cm. in length in the center of the removed mass. A review of the preoperative roentgenograms then revealed the same bone shadow in the right lower quadrant of the abdomen. Postoperative roentgen studies showed disappearance of the shadow.

Four figures show the shadow of the bone on the preoperative films and in the surgically removed mass.—*E. E. Seedorf, M.D.*

Root, Joseph C., and Greenwald, Charles M. Double contrast study of colon: routine lateral recumbent view. *Radiology*, Aug., 1954, *63*, 241–245.

The authors advocate the routine use of lateral recumbent views as a survey procedure in double contrast study of the colon. Following fluoroscopy, six roentgenograms are routinely obtained. The first group of three are made with the vertical beam in the posteroanterior, anteroposterior and left posterior oblique views. Subsequently roentgenograms in the left and right decubitus views are obtained. The patient is then allowed to empty the colon and a final posteroanterior roentgenogram is taken.

Emphasis is placed on good preparation of the patient and a definite planned routine for conducting the examination. The patient is placed on a low-residue diet for forty-eight hours prior to the study. One ounce of castor oil is administered about twenty hours before the examination. Several hours before the double contrast study is performed, tap water enemas are given until the return is clear.

A review of all roentgenologically demonstrated polypoid lesions which were surgically removed at the Cleveland Clinic since 1950 shows a definite superiority of the decubitus roentgenograms over those made in the more conventional views. In most instances the diagnostic quality of the decubitus films was considerably better than of those exposed in the vertical beam projections.—*Arno W. Sommer, M.D.*

Keefer, George P., and Mokrohisky, John F. Congenital megacolon (Hirschsprung's disease). *Radiology*, Aug., 1954, *63*, 157–175.

Hirschsprung first described congenital megacolon in 1887, but not until Tittel's work in 1901 and Dalla Valle's report in 1920 was the true nature of this disease entity established. The absence of ganglion cells in the normal appearing bowel led to Swenson and Neuhauser's work in the roentgen diagnosis and surgical treatment which is now generally accepted.

Cases of megacolon may be divided into three main groups: (1) organic megacolon due to any obstructing organic lesion, (2) idiopathic megacolon which is probably on a functional basis, and (3) congenital megacolon or Hirschsprung's disease.

About 90 per cent of cases of congenital megacolon will show a short aganglionic segment involving the rectum and a portion of the sigmoid. Many variations do occur, however, up to including the entire colon being aganglionic. At times aganglionic segments may have normal bowel separating them. In a few reported cases the ganglion cells are absent in the small intestine and throughout the colon. In these instances diagnosis is very different because of lack of colon dilatation.

The typical symptoms of congenital megacolon are constipation shortly after birth, progressive abdominal distention and vomiting. Of interest to the roentgenologist is the fact that a clinical picture of shock may occur if excessive tap water enemas are used. The rapid diffusion of water into the circulation via the large absorptive surface of the dilated bowel is the reason for this occurrence.

The roentgen examination consists of the use of a suspension of barium in normal saline and the introduction of only enough to demonstrate the area of narrowing, plus a short segment of the dilated colon. The double contrast procedure is helpful in determining the location of the narrowed segment.—*Clyde A. Stevenson, M.D.*

Gynecology and Obstetrics

Walsh, John W., Haas, Stuart L., and Maclean, Marian E. Isometric pelvimetry. *Am. J. Obst. & Gynec.*, Aug., 1954, *68*, 674–690.

In achieving an ideal method of roentgen pelvimetry, a purely quantitative approach to the problem is not sufficient. The method with most universal appeal should be one that offers a complete survey of pelvic architecture and cephalopelvic relationship, and one which can be interpreted by the obstetrician with ease. From the technician's point of view, the method should be uncomplicated to set up, and, to the patient, it should cause minimal discomfort. It should utilize a minimum of exposure to roentgen rays. The method should be readily adaptable for use not only in teaching clinics, but also in the farthest outposts of medical practice where roentgen apparatus is available. In the authors' experience, isometric pelvimetry more closely approaches the ideal than any one of the many techniques currently in use throughout the country. They offer a preliminary report on and a discussion of their experience with this technique and interpretation of the roentgenograms.

Routine study of the birth canal and its contents is made by utilizing two roentgenograms. In the presence of breech, transverse, or oblique presentations, twins, or instances of a floating head so high that it cannot be seen in the regular films, a flat roentgenogram of the abdomen is also taken. A 4

inch sheet roll is placed against the lumbosacral curvature, and three firm pillows are arranged lengthwise beneath the shoulders and back. This position angulates the pelvis forward and brings the inlet parallel or almost parallel to the table, effecting an undistorted view of the pelvic inlet.

The patient assumes the same position for the lateral roentgenogram. In this case, however, she is moved to a standard hospital stretcher which has been covered with a rigid plywood board. A notched metal centimeter rule is placed in front of the symphysis in a vertical position. The roentgen table is turned to the vertical, and the patient is rolled into position in front of it with one hip touching the table. The tube for this lateral roentgenogram is centered at 36 inch tube distance on a line equidistant between the trochanters and the posterior superior iliac spines.

Measurements in the lateral view are calculated from the perforated lead ruler on each patient's films. The frontal measurements are made from a distorted centimeter scale, which is made at varying heights from 1 to 16 centimeters.—*Eugene J. McDonald, M.D.*

Wolf, B. S., and Loevinger, Robert. Practical telepelvimetry. *Radiology*, Aug., 1954, *63*, 220 225.

The authors investigated the possibility of utilizing long target-film distances for pelvic mensuration in order to minimize magnification. To avoid excessively long exposures, factors of 120 kvp. and 100 ma. were adopted. The routine roentgenographic tube had an added filter of 2 mm. of aluminum. The 16 to 1 grid was found to be necessary to obtain roentgenograms of satisfactory quality. The required time of exposure did not exceed two seconds at a target-film distance of 72 inches.

Their method was based on the familiar stereoroentgenometric technique. A target-film distance of 72 inches was maintained. A tube shift of 8 inches was used, and lead markers were placed on the table top to permit accurate registration of the two films. This permitted investigation of the variation in the magnification factors from patient to patient for the pertinent transverse pelvic diameters. Over 100 patients were examined by this method.

Correction factors were established for target-film distances of 72 and 60 inches. The results are in essential agreement with those obtained by other investigators.—*Arno W. Sommer, M.D.*

Holm, Olov Fr. Free gas in the fetal vessels as a roentgenologic sign of intra-uterine fetal death. *Acta radiol.*, Aug., 1954, *42*, 116–120.

In roentgenologic investigation of fetal death it is advised to check:

1. Signs indicating the absence of fetal life, *i.e.:*
   a. Absence of continuous growth
   b. No evidence of movement on serial roentgenograms with mother stationary
   c. Amniography
2. Signs of maceration in (A) Head; (B) Body:
   A. Head:
      a. Spalding's signs (not infallible)
      b. Flattening of convexity
      c. Severe asymmetry
      d. Enlargement—separation of bones
      e. Narrow clear zone around head—a halo
   B. Body:
      a. Severe curvature of the spine
      b. Marked lordosis in caudal part
      c. Decrease in skeletal content
      d. Possible turning of the head of the fetus to 180°
      e. Occurrence of free gas in fetal vessels.

With respect to the latter sign, 5 cases are reported in the literature and the author adds a sixth case as showing gas in the heart, ascending aorta, head and the liver.

It is postulated that in the breakdown of hemoglobin, oxygen may rapidly be liberated in the vessels as free gas and not all absorbed.—*Wallace M. Roy, M.D.*

Genitourinary System

Idbohrn, Hans. Delayed excretion in urography and its significance. *Acta radiol.*, July, 1954, *42*, 1–10.

Boeminghaus (1932) after animal experiments on kidney function with contrast media concluded:

1. Rapid filling of the renal pelvis and ureter with the contrast medium suggests transient stasis.

2. Accumulation of the medium in the parenchyma suggests only several hours' obstruction of the ureter.

3. Slight or practically absent excretion of the contrast medium suggests the ureter has been obstructed for several days.

Various investigators have furthered this type of work and noted that elimination of obstruction in the acute case assures the kidney of reassumed function.

However, in some cases of longer obstruction (due to stone, constricting inflammatory lesion or tumor) it is found that urinary stasis persists. What then is the extent of functional impairment in these cases? With respect to urographic findings the impairment is not easily assessed because:

1. It is not possible to determine the onset of the obstruction, as the obstruction may be partial or intermittent.

2. The importance of the time factor in stasis is not agreed upon. For instance, renal stasis is often associated with infection and in hydronephrosis the

presence of infection favors destruction of the parenchyma and inhibits regeneration. Infection can cause more damage than obstruction. Also, when power of regeneration is assessed, the state of the other kidney has to be considered.

3. Different anatomic changes are capable of producing essentially the same roentgenographic appearance.

Experiments have shown that excretion may be decreased or absent despite a healthy parenchyma, as is seen in low blood pressure. And conversely, in renal parenchymal damage there may be good excretion as in locally destructive lesions (tuberculosis, etc.); here the remaining unaffected portion can produce ordinary concentration of the contrast medium.

The author includes 4 cases histories to substantiate his opinion that urograms will not permit any conclusions about the power and extent of recovery of the kidney after the elimination of stasis. In other words, it does not show if the impairment is permanent or temporary.

He suggests that a more informative method is required and as "a kidney is no better than its arterial supply" renal angiography may be part of the answer.—*Wallace M. Roy, M.D.*

Hancock, Reginald A., Lee, James J., and Anderson, Joseph B. Giant hydronephrosis; one stage nephrectomy. *J. Urol.*, Aug., 1954, *72*, 130–132.

A seventy-two year old while male was admitted to the hospital in June, 1951, with a history of progressive abdominal enlargement over the past ten years. There was only one episode of pain in the left flank, associated with gross hematuria, two weeks prior to admission. The patient had been well all of his life except for minor illnesses. Physical examination revealed the only significant findings in the abdomen where there was enlargement (measuring 45 inches), tenseness, dullness to percussion without any fluid shift and absence of peristalsis. Abdominal roentgenogram showed marked elevation of the left diaphragm, a stag-horn calculus below the lower pole of the right kidney, and a round calculus in the lower left ureter. The excretory urogram revealed complete absence of the opaque medium in the left kidney and ureter and a normal right renal pelvis with the ureter displaced to the right; the stomach and small intestine were displaced to the right, the transverse colon upward, and the sigmoid and descending colon to the left. At cystoscopic examination the left ureter could not be catheterized beyond the intramural portion.

A one stage nephrectomy was done and a giant hydronephrotic left kidney was removed containing 12 liters of blood-tinged urine which was sterile. The stag-horn calculus was impacted in the left ureteropelvic junction. The patient's postoperative course was uneventful and at discharge, twelve days after operation, the abdomen measured 36 inches.—*Olin S. Allen, II, M.D.*

Hall, M. R. Traumatic rupture of the kidney. *Radiology*, Aug., 1954, *63*, 230–234.

In patients with traumatic rupture of the kidney, the radiologist can play a very important part, not only in establishing the diagnosis, but also in helping the clinician decide on the proper course of management. Information secured from subsequent films is of definite aid in the follow-up. Plain films of the abdomen are of value, but excretory pyelograms should also be obtained on admission, because of the important additional information that can be gained. There is some question as to the advisability of retrograde pyelography.

Plain films, if the renal areas are not obscured by overlying gas-filled bowel, may show loss or enlargement of the kidney shadow, obliteration of the psoas muscle shadow, scoliosis with concavity to the affected side, and evidence of other trauma such as rib and vertebral fractures.

Excretory pyelograms may reveal significant changes, such as extravasation of medium into the renal parenchyma, or deformity of the calyces, pelvis, or ureter from intrarenal blood clots, or external pressure. Valuable information in regard to the status of the opposite noninjured kidney is also obtained.

In this series, roentgenographic studies revealed the presence of unsuspected pre-existing renal disease in 23 per cent of the 17 patients seen. The pathology consisted of cysts, hydronephrosis, malignant tumors, and calculi.—*C. L. Stevenson, M.D.*

Tresidder, G. C. Ureterograms. *Brit. J. Urol.*, Sept., 1954, *26*, 240–248.

The author describes his technique of performing ureterograms, and points out that, in some cases, it may be a valuable procedure, and the renal pelvis may be shown just as well as in the usual manner. He recommends it in cases of suspected obstructive hydronephrosis, since frequently ureteral catheters will pass the point of obstruction, and not adequately demonstrate it. Secondary infection should be less frequent. This procedure is very useful in diagnosing primary ureteral tumors.—*George L. Sackett, Jr., M.D.*

Mattoso Filho, J. Signo radiológico de cálculo ureteral intramural. (Roentgen sign of intramural ureteral stone.) *Arch. españ. urol.*, 1954, *10*, 71–74.

In certain cases of stones detained in the intravesical portion of the ureter an intravenous pyelogram will show a translucent area around the calculus, contrasting with the greater density of the bladder filled with contrast medium. The translucent

area would be due to ureteral prolapse or most probably edema of the mucosa.

This sign has prognostic significance, since it has been noted that in all cases where it occurs the stone is eliminated within forty-eight hours.—*F. Comas, M.D.*

St. Martin, E. C., Pasquier, C. M. Jr., and Campbell, J. H. Ureteral complications of radical surgery for carcinoma of the cervix. *South. M. J.*, Sept., 1954, *47*, 832–837.

With the increasing use of radical surgery for Stage I and II carcinoma of the cervix, urological complications have been of sufficient incidence to give information as to their nature.

The most common and serious complication is ureteral injury, the second is vesicovaginal fistula, and the third is vesical dysfunction. In Meigs' first 65 cases, he had an incidence of 12.3 per cent of ureteral fistulae. This was attributed to stripping the blood supply from the lower ureters. Now an attempt is made to preserve as much blood supply to the lower ureter as possible, particularly by sparing the medial attachment of the ureter to the peritoneum.

When an injury has developed, the usual sequence is: avascular ureteral necrosis, retroperitoneal extravasation of urine and fistula formation. The latter usually manifests itself as an ureterovaginal fistula ten to twenty-one days after surgery. Then follows ureteral stricture, hydroureter and hydronephrosis, and renal damage due to obstruction and infection. The stricture is difficult to manage because of the ischemic necrosis.

At the Shreveport Charity Hospital, Louisiana, 50 patients had a Wertheim operation between 1950 and 1953. Although a few had radioresistant carcinomas of the cervix, most were adequately treated by radiation therapy and were part of a statistical study to determine the salvage combined with surgery. No residual malignancy was found in 86 per cent of the removed tissues. In 15 patients (30 per cent) ureteral injuries occurred, and in 7 these were bilateral. The degree of injury varied from mild obstruction to that requiring bilateral nephrostomy. The more frequent and severe injuries occurred in these cases in which block dissection was done as contrasted to those cases in which the lymph nodes were removed in groups.

Treatment is individualized. Dilation of the ureter may suffice. If fistula occurs and the local reaction is marked, nephrostomy is done followed by later anastomosis of the ureter with the bladder or bowel. Every effort must be made to preserve as much renal function as possible because of the high incidence of bilateral damage. In this series there was 54.5 per cent salvage of good kidneys.

In their conclusion the authors state "The skillful use of radiotherapy . . . today produces considerably fewer complications, much less morbidity, and a comparable salvage. It would seem, therefore, that surgery should be reserved for radioresistant carcinoma of the cervix."—*Henry J. Klos, M.D.*

de Moura, Carneiro, and de Carvalho, Pinto. Neumo-testículo. (Pneumotesticle.) *Arch. españ. urol.*, 1954, *10*, 39–49.

A new method to visualize the testicle and epidydimis by means of air contrast roentgenograms is described.

After locally infiltrating the scrotum with an anesthetic solution, a needle is introduced into the pouch investing the testicle, taking care not to puncture the testicle; any hydrocele fluid is drained, and from 40 to 100 cc. of air is injected. Upon withdrawal of the needle roentgenograms are taken, in which the testicle and epidydimis shadows are well delineated. Images of hydrocele, epidydimitis and spermatic cysts are shown and the method is also thought to be of value in the diagnosis of testicular tumors. No untoward effects have been observed, the air being re-absorbed in two or three days.—*F. Comas, M.D.*

de Moura, Carneiro, and de Carvalho, Pinto. Pneumo-testiculo. (Pneumography of the testicle.) *Acta. iber. radiol. cancerol.*, July–Sept., 1954, *3*, 369–374.

The authors recommend a very simple technique. The material required is an antiseptic solution; 1 per cent novocaine solution; 2 sterile hypodermic needles, one fine, one large in caliber; and a 5 cc. syringe and a 20 cc. syringe, both sterile. After disinfecting the skin of the scrotum, local anesthesia is initiated and puncture made with the large needle into the vaginal cavity. If there is hydrocele, the fluid is withdrawn before the air is injected. Care must be taken not to make the air injection into the scrotal wall. Forty to 100 cc. of air usually suffices, the latter amount in cases of large hydrocele. The air is almost totally absorbed within the first two or three days. Accidental puncture of the testicle, an occurrence easily avoided, might offer some real danger in case tumor is present. The roentgenograms are always made in two planes.

The authors had no unpleasant experiences in their use of the pneumographic method. It offers a possibility of thorough study of chronic and acute changes in the scrotal pouch, as well as of cysts in the inguinal canal.—*James T. Case, M.D.*

Nervous System

Boijsen, Erik. The cervical spinal canal in intraspinal expansive processes. *Acta radiol.*, Aug., 1954, *42*, 101–115.

It is well known that tumors in the spinal canal are capable of causing pressure atrophy and subse-

quent widening of the canal. The author states that in the cervical region measurement of interpediculate distance is less apt to show enlargement of the canal than is measurement of the sagittal diameter. To establish the normal variation he measured the anteroposterior diameter of 100 male and 100 female cervical spines. This was greatest at the atlas, decreased caudally and was practically uniform from C_5 to C_7. The range of normal variation is considerable. It depends partly on examination technique and body build but it is chiefly due to normal variation in the cervical region. Provided the tumor involves the entire cervical part of the spinal canal considerable pressure atrophy is necessary to produce roentgenographic changes, especially if the original sagittal diameter lies near the lower limit of normal. This is not the case if the tumor is localized to one or two of the cervical vertebrae, for under these circumstances comparatively small variations will be evident by comparison with adjacent segments.

The roentgenographic findings in 12 consecutive patients who had primary expansive processes in the cervical part of the spinal canal are discussed. Two out of 3 cases of syringomyelia were found to have expanded cervical canals best shown by sagittal measurements. These were 5 cases of glioma and in 2 of these the spinal canal was definitely widened mostly in the sagittal direction. Skeletal changes were demonstrated in 3 out of 4 cases of neurinoma, but in 2 they were confined to the intervertebral foramina. In the third the sagittal diameter of the spinal canal at the level of the tumor was abnormally large.—*Arthur E. Childe, M.D.*

Skeletal System

Schajowicz, Fritz, and Cabrini, Romulo L. Histochemical studies of bone in normal and pathological conditions; with special reference to alkaline phosphatase, glycogen and mucopolysaccharides. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 474–489.

The histopathological studies of biochemical changes in bone in this article are devoted especially to reference to alkaline phosphatase, glycogen and mucopolysaccharides. These studies were made in normal growing bones of mice, rats, and men, also in 40 cases of pathological bone processes both neoplastic and dystrophic. For assessment of histochemical findings in the process of ossification the existence of two fundamental types of ossification, namely, the endochondral and the membranous, should be borne in mind. In endochondral ossification there is a previous stage which takes place in the cartilage and which is characterized by its proliferation, hypertrophy and subsequent calcification. Only then, and after its destruction, are the actual bone trabeculae formed. On the other hand, the cartilage has no part in the mechanism of membranous or direct ossification, where the osteoblastic elements originate first, then the fundamental (osteoid) substance, and later true calcified bone.

The authors stated that most biochemical studies of the formation of bone have stopped at the calcification of hypertrophic cartilage. In reality, calcification of the cartilage is a previous stage in endochondral ossification and has no part in direct ossification; on the other hand, the cartilage can become calcified without subsequent ossification. Their studies of normal material confirmed that alkaline phosphatase is plentiful in calcification of cartilage and even more plentiful in bone formation, whether endochondral or direct. They observed that glycogen increased in the cartilage areas about to be calcified, and it disappeared in those calcified. It seemed that osteoblasts did not always contain glycogen. They ascribed the large amount of phosphatase in their case of liposarcoma to the importance conferred on the phosphate radical in the metabolism of lipids. In Paget's disease, as well as in fibrous dysplasia, considerable phosphatase activity was observed in the young connective tissue stroma that separated the bone trabeculae, in accordance with the osteogenic power that the authors believe this tissue has. They stress that in the study of giant cell tumors, they did not observe any important phosphatase activity in the stroma or in the giant cells and saw it only in small blood vessels. Although these tumors contained a great amount of reticulum fibers which surrounded almost all the cells, the absence of phosphatase in the stroma allowed them to discount its influence on the development of reticulin fibers in the tumors.

In the pathological material (tumors and dystrophic processes) there was great phosphatase activity in the osteogenic areas and also in the cartilage about to be calcified. Whereas glycogen was plentiful in some cases of neoplastic or reactive osteogenesis, it was absent in others. In every area of normal or pathological ossification, the presence of phosphatase seemed to be the rule; glycogen was often, but not always, present. It appeared that alkaline phosphatase plays an important role in the formation of the protein matrix of bone, but is not associated with the elaboration of the nonprotein cartilage matrix. They believe it is premature to draw any definite conclusion on the behavior and role of the metachromatic substances in the process of calcification and ossification.—*Ralph S. Bromer, M.D.*

Wierman, William H., Clagett, O. Theron, and McDonald, John R. Articular manifestations in pulmonary diseases; an analysis of their occurrence in 1,024 cases in which pulmonary resection was performed. *J.A.M.A.*, Aug., 21 1954, *155*, 1459–1463.

The authors use the term "articular manifestations" to include: (a) clinically observable digital clubbing, (b) long bone periosteal proliferation, and

(c) rheumatoid-like pains in the joints of the extremities. They believe with Hansen that clubbing of the fingers and chronic pulmonary osteoarthropathy are similar reactions, the former being local and the latter more generalized. The periosteal proliferation is more likely to occur with a localized pulmonary lesion such as carcinoma, and it has a more rapid course in its development and disappearance. Clubbing of the fingers usually but not invariably precedes the development of periosteal proliferation.

The report is based upon the study of 1,024 cases in which pulmonary resection was performed. The authors use the term "arthropathy" to include any of the objective manifestations mentioned above (*i.e.*, clinical or roentgenological).

Arthropathy was found in 8 patients having pleural mesothelioma (an incidence of 57.1 per cent). The incidence of this finding was 17.6 per cent in lung abscess, 10 per cent in pulmonary cysts, 9.5 per cent in bronchiectasis, and 5.2 per cent in malignant tumor. In tuberculosis the incidence was only 0.6 per cent. It was never found in the presence of benign tumors, granulomas, etc. Although the incidence of arthropathy was only 5.2 per cent in 481 resections for malignant tumors, malignant tumors were so common that they accounted for more cases of arthropathy than any other group.

Digital clubbing was the commonest manifestation of pulmonary osteoarthropathy in this large series. Infrequently, arthralgia related to pulmonary disease preceded the actual development of clubbing or periosteal reaction. In patients with suppurative disease and pulmonary tuberculosis there was no arthralgia. The authors believe that painful articular manifestations are usually the result of pleural mesothelioma or other malignant pulmonary lesion.

The pathogenesis of pulmonary osteoarthropathy is still obscure. The authors express the opinion that pleural stimulation or involvement by the thoracic lesion may be a factor in the development of pulmonary osteoarthropathy.—*C. L. Hinkel, M.D.*

Engfeldt, B., and Zetterström, R. Osteodysmetamorphosis fetalis; a clinical-pathological study of a congenital skeletal disease with retarded growth, hypophosphatasemia and renal damage. *J. Pediat.*, Aug., 1954, *45*, 125–140.

The authors present a case of congenital skeletal disease in a five month old girl with retarded growth, hypophosphatasemia and renal damage.

Clinically, the infant progressed satisfactorily until the age of three months when she developed anorexia, vomiting, became hypotonic and flabby and ceased to gain weight. The subsequent course revealed repeated upper respiratory infections with fever, physical retardation, slight weight loss, and persistent nausea and anorexia. The extremities became rather short in relation to the trunk. There was increasing respiratory difficulty with deep retractions owing to softness of the thoracic skeleton. The patient died with symptoms of pulmonary and cardiac failure.

The physical examination revealed a persistent hypertension (160–240 mm. Hg). The eyes showed normal media and fundi with no evidence of increased intraocular pressure. There was moderate rachitic rosary and swelling over the ankles and wrists. At the age of nine months, a sharp thoracolumbar kyphosis appeared.

There was a constant but slight normochromic anemia. The urine was normal except for a trace of albumin which was constantly present. The excretion of calcium was somewhat higher than normal (936 mg. in 3 days) with a serum-calcium concentration of 12.0 mg. per 100 ml.

Roentgenographic examination revealed normal upper urinary tracts with no evidence of renal calcification. The skeleton demonstrated low mineralization generally. The metaphyses showed considerable fraying, fragmentation and deformation. There was widening of the epiphyseal lines and large diastases were present between the bones of the calvarium due to the absence of mineralization. Distinct changes were also noted in the structure of the epiphyses. There was a normal number of bone centers.

The blood chemistry revealed a mild but constant hypercalcemia, the serum phosphate was normal and the alkaline phosphatase was lower than normal. There was a slight but constant increase in the nonprotein nitrogen and the acid-base balance was normal except in the terminal period. There was a considerable increase in the gamma-2 globulin. There was no evidence of the occurrence of any substance that might inhibit phosphatase activity.

Postmortem examination revealed calcium casts in the renal tubules as well as calcium salts around the tubules and interstitially. The bones showed the proliferating cartilage to be irregularly calcified with reduced numbers of osteoblasts and osteoclasts. The compact bone tissue in the diaphyses was of an immature type, and mature haversian systems could be observed in only a few areas. The alkaline phosphatase activity was very low in the bone tissue and depressed in the kidneys.

The most characteristic features of the skeletal disease were inhibited skeletal development, considerably reduced rebuilding of bone, and deficient mineralization of the newly formed organic matrix. The investigation failed to reveal evidence that the skeletal changes were secondary to a renal disease. It appears that the disease is caused by disturbed cellular function and a generalized deficiency in the alkaline phosphatase activity.—*James F. Martin, M.D.*

Walker, O. B., and Hanafee, William N. Planographic diagnosis of osteomyelitic sequestra. *J. Bone & Joint Surg.*, July, 1954, *36-A*, 750–756.

Most sequestra in osteomyelitis can be identified by regular two-dimensional roentgenographic technique; others can be identified by sinography, three dimensional roentgenography and other specialized techniques. Laminagraphy has been utilized by the authors to demonstrate previously unvisualized sequestra in recurrent and chronic osteomyelitis.

In a series of 22 cases of chronic osteomyelitis, no evidence of sequestra could be demonstrated by regular roentgenographic technique. In 9 of these cases, sequestra were shown by laminagraphy, and the findings were confirmed at operation. Among these was one patient who had been operated upon several times unsuccessfully, and in whom the causative sequestrum was finally demonstrated by laminagraphy to be at a considerable distance from the previous sites of surgery.

The chief criteria for recognition of sequestra by laminagraphic technique are: (1) the demonstration of an area of density with a surrounding area of translucency, and (2) persistence of this halo effect through a sufficient series of successive laminagrams to exclude the possibility of a bone peninsula. The authors state that they do not consider the use of laminagraphy a routine procedure in the diagnosis of osteomyelitic sequestra. Reproductions of the roentgenograms of several of the cases are included in the article.—*Ralph S. Bromer, M.D.*

Meyer, R. Bone abscess caused by bacterium coli. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 436–437.

A girl, eighteen years of age, complained of general weakness and pain in the right knee for two weeks, during which time there had been mild pyrexia. There was no history of recent illness and she had never been treated by antibiotics for any disease. Roentgenographic examination revealed a sharply defined osteolytic lesion with slightly osteosclerotic wall in the lateral condyle of the femur. At operation a bone abscess was found. A report of pure culture from the pus secured at operation of *Bacterium coli* was obtained. This was sensitive to chloromycetin only. Treatment with chloromycetin promptly cured the lesion, the chloromycetin having been instilled into the wound.

No reference to a bone abscess caused by *Bacterium coli* could be found in the literature. The possibility that this was a sterile abscess and that the organisms were contaminants was dismissed as the treatment indicated by the sensitivity test had prompt success. The author states that this case may serve as a contribution to the question raised by Howard (1951) whether local administration of antibiotics has much effect in osteomyelitis.—*Ralph S. Bromer, M.D.*

Shannon, J. G., and Woolhouse, F. M. Treatment of chronic bone infection. *J. Bone & Joint Surg.*, July, 1954, *36-A*, 841–850.

The purpose of this article is to report the results in 82 cases of chronic bone infection. The authors believe that the radical excision of diseased bone and of the ischemic and fibrosed soft tissue, the immediate covering of the defect created with a split-thickness skin graft and when necessary the subsequent filling of the defect with bone covered with a pedicle skin graft constitute the best treatment for chronic infection of bone. The article is illustrated with drawings of the operative procedures, clinical photographs and reproductions of roentgenograms of cases operated upon.

No difficulty was experienced in securing a satisfactory "take" of the skin graft. If any minute pieces of detached bone are left on the surface of the cavity they will perforate the skin graft and the small defect will quickly epithelialize. If, on the other hand, a larger area of infected or eburnated bone has been allowed to remain at the time of débridement, there will be a corresponding slough in the skin graft. Such an area can be re-excised and covered with a small skin graft.

This immediate application of suitable skin to the cavity protects the bone exposed at the time of débridement from the ingress of additional infection and prevents the pocketing of soft tissue infection by obliterating all dead space. This method also arrests the progressive fibrosis of the soft tissue walls because it permits healing by primary intention.

The authors state that while their procedures are obviously not advocated as a routine measure for joint tuberculosis or septic arthritis, they believe that their usefulness in certain of these cases has been demonstrated.—*Ralph S. Bromer, M.D.*

Dwinnell, Leonard A., Dahlin, David C., and Ghormley, Ralph K. Parosteal (juxtacortical) osteogenic sarcoma. *J. Bone & Joint Surg.*, July, 1954, *36-A*, 732–744.

This article is a report of the study of 15 cases of parosteal osteogenic sarcoma. This lesion is a relatively rare bone tumor, characterized by a low degree of malignancy. It has a marked predilection for the lower end of the femur, and it is attached to the cortex by a broad base. It is ordinarily believed to be an atypical osteochrondroma by the roentgenologist and frequently confuses the pathologist by its subtle evidence of malignancy.

Seven of the patients in the series reported were males and 8 were females. Ten of the fifteen tumors involved the distal end of the femur, two affected the proximal portion of the humerus and one the distal; one was found in the proximal and one in the distal part of the tibia. The presenting symptom was the presence of the mass. Seven patients had noted no pain, while the remaining 8 had noted mild pain of short duration. Only 5 patients had experienced loss of range of motion of the neighboring joint.

In the roentgenograms, the typical tumor appeared as a dense lobulated mass attached to the metaphyseal region and sometimes to the epiphysis of a long bone. All the tumors were attached by a broad base, and all but one were described as being sclerotic. In most cases, there were also areas of lesser density scattered throughout the tumor.

The tumor was usually lobulated. Its borders were ordinarily sharply defined, but in some of the tumors the border was indistinct where it blended with the surrounding tissue shadows, As the tumor grew, it sometimes extended along the shaft, but it almost always tended to surround the bone. In some instances the latter process was complete, the shaft of the bone then running through the tumor. Reactive periosteal new bone formation and medullary involvement were conspicuously absent in the primary lesions. In 1 case in which there was apparent medullary involvement in the primary lesion the tumor was easily shelled off the cortex, leaving a smooth base. The circumferential growth of the tumor outside the cortex gave the erroneous impression in the roentgenogram of medullary involvement. Recurrent lesions often did show actual and sometimes prominent medullary involvement and exhibited obvious roentgenographic features of malignancy.

A feature observed in the microscopic sections was the presence of beams of nonmalignant bone which surrounded spaces filled with atypical spindle or polyhedral cells, among which occasional or sometimes numerous mitotic figures were seen. Variable amounts of new osteoid were usually observed among the proliferating spindle cells. The larger zones of new osteoid frequently showed calcification. The smaller masses seemed to blend with the fibrosarcomatous elements as though the latter were undergoing metaplasia to a type capable of producing osteoid. Islands of cartilage were seen throughout most of the tumors.

The differential diagnosis includes osteochondroma and exostosis with a broad base in which the cartilage present is in the form of cap rather than scattered throughout the tumor. Chondrosarcoma, heteroptotic ossification as in myositis ossificans, active ossification (callus) in a healing fracture or in an otherwise injured bone, and the markedly exuberant callus formation observed in some cases of osteogenesis imperfecta must also be differentiated.

Five patients of those studied have died: 3 of metastatic growths, 1 three days after re-amputation for recurrence in the stump and 1 of unknown cause. One patient died fifteen years after her amputation with widespread metastasis confirmed at necropsy. Roentgen therapy was administered in 3 cases. It did not seem to alter the course of the tumor in 2 of them.—*Ralph S. Bromer, M.D.*

Brailsford, James F. Paget's disease of bone. *Brit. J. Radiol.*, Aug., 1954, *27*, 435–442.

The author reviews James Paget's accurate initial description of osteitis deformans and points out that, since this first report, little additional knowledge of the condition has been gained except that today it is recognized earlier. The roentgenographic changes are most commonly observed in the spine and pelvis and may resemble foci of malignant metastases. The author states that the appearance of the early subperiosteal lesion in long bones is characteristic, the boundary being clearly defined in the form of a "V" line which separates the normal from the Paget bone. The early endosteal focus is not so clearly defined.

The stages of development are divided into: the osteoporotic, in which the bones are decalcified; the osteoplastic, in which the bones are more dense than normal; and the lithocystic, in which the bones are thicker and more dense and present cyst-like spaces.

The manifestations of skull involvement are: osteoporosis circumscripta and, more commonly, the cotton wool-like pledgets in thickened decalcified areas which ultimately may involve the entire skull.

Bones which have been altered in form and pattern as a result of osteomyelitis, tuberculosis, trauma, neuropathic disturbances and exostoses, all may undergo the Paget changes of adjacent bone.

The author points out the ease with which the osteoplastic form of metastatic carcinoma may be confused with Paget's disease. The salient features of differentiation from fluorosis, osteomyelosclerosis, Albers-Schönberg disease and hyperparathyroidism are presented.—*Thomas F. Meaney, M.D.*

Wilton, Åke. On the genesis of osteitis deformans (Paget). *Acta orthop. Scandinav.*, 1954, *24*, 30–43.

The author studied 19 clinically diagnosed cases of Paget's disease, in 14 of which it was possible to corroborate the diagnosis. He discusses various theories of the etiology of this disease. He discards the theory that it is a form of osteitis, with the bone changes being dependent upon inferior new bone formation due to the inflammatory process, as there are no signs of inflammatory changes. The fact that two or more members of one family may suffer from such a rare disease is strong evidence in support of the view that the abnormally small developmental capacity of the bone tissue is caused by hereditary factors.—*D. S. Kellogg, M.D.*

Sherman, Robert S., and Soong, Kenneth Y. A roentgen study of osteogenic sarcoma developing in Paget's disease. *Radiology*, July, 1954, *63*, 48–58.

The incidence of osteogenic sarcoma complicating Paget's disease varies widely according to different observers. It is known, however, that many sar-

comas found in individuals in the higher age groups are associated with Paget's disease. The authors present their findings in 19 biopsy-proved cases of osteogenic sarcoma occurring in areas of this disease. Sixteen showed multiple involvement by osteitis deformans and in the remainder the lesions were monostotic.

The authors use a simple method of classifying osteogenic sarcoma roentgenographically on the basis of site of origin and relative degree of destruction or bone production. In this series there were 14 tumors that were osteolytic, 7 mixed, and 1 of the sclerotic variety. All arose from the bone itself, the less common periosteal or extraosseous origin not being found in this series, or reported in the literature in conjunction with Paget's disease. Sixteen of the sarcomas were thought to have arisen in the medullary part of the bone. Two others probably arose from this location, and 2 arose from the cortex. In 2 cases the primary site could not be determined

There were 3 osteogenic sarcomas in Paget's disease of the cranial vault as contrasted to the rarity of this location in large series of primary bone sarcomas. They were all of the osteolytic variety. The presence of a pulsating mass was the most important clinical characteristic in this location. Pain, "arthritis," and fracture were the usual complaints in locations other than the skull.

Osteogenic sarcoma usually develops as an area of bone destruction in Paget's disease. This is subcortical in location initially, with subsequent cortical destruction. Rapid growth is the rule. The borders are indistinct with no periosteal reaction. Generally a soft tissue mass is present. Usually there is no joint involvement. It is felt that metastasis to normal bone and lung are not infrequent, although multicentric origin in bone may occur.

In the authors' experience it is impossible to differentiate reliably between cancer metastasis and osteogenic sarcoma occurring in areas of Paget's disease, except possibly for the uncommon sclerotic form of osteogenic sarcoma.—*Michael J. Healy, M.D.*

Francis, Kenneth C., Higinbotham, Norman L., and Coley, Bradley L. Primary reticulum cell sarcoma of bone; report of 44 cases. *Surg., Gynec. & Obst.*, Aug., 1954, *99*, 142–146.

The authors present from Memorial Hospital of New York a series of 44 cases, 8 of which are new and 37 were previously reported in 1950. (In 1 patient of the original series the autopsy findings later proved to be those of Ewing's sarcoma; therefore, this case has been deleted from the present series.)

The age of the patients ranged from eleven to sixty-seven years (average 34 years). There was a 2:1 ratio of males to females. There was a 2:1 ratio of the disease occurring in the long bones of the extremities as compared to the bones of the trunk. No definite relationship of trauma as an etiologic agent has been shown.

The reticulum cell in the primary type is histologically indistinguishable from the generalized type. Differentiation from Ewing's sarcoma and metastatic neuroblastoma may be very difficult.

Pain is the most significant initial symptom, and a palpable mass or soft tissue swelling is the most common finding. Most patients generally seem to be in better health as compared to the extent of disease. Tenderness, local heat and fever are noted less often in that order of freqeuncy.

Five year survival without evidence of disease is 48.4 per cent as compared to the original report of the authors in 1950 of 47.6 per cent. Ten year survival without evidence of disease is 33.3 per cent as compared to the previously reported 38.5 per cent.

The authors conclude from their data that the most efficacious thereapy is irradiation of the primary lesion in addition to one or more courses of Coley's toxins. Amputation is definitely not indicated except in the treatment of complications which might arise.—*George A. Miller, M.D.*

Baker, Perren L., Dockerty, Malcolm B., and Coventry, Mark B. Adamantinoma (so-called) of the long bones; review of the literature and a report of three new cases. *J. Bone & Joint Surg.*, July, 1954, *36-A*, 704–720.

In this article a report of the study of 27 cases of adamantinoma (so-called) is made. In the series, the age of the patients ranged from twelve to fifty-seven years. The tumor involved the tibia in 24 cases, the femur in one, and the fibula in one. The authors state that the purpose of their study is to ascertain whether so-called adamantinoma of the long bones metastasizes, that is whether it is malignant, and what is the treatment of choice.

The term "adamantinoma" which indicates a tumor consisting of enamel, is probably misleading. No enamel has been found in such tumors occurring in long bones, and some pathologists have expressed doubt that it has been demonstrated in other locations. Until more is known of the pathogenesis of this tumor, the authors consider it be wise to refer to it as "adamantinoma (so-called) of the long bones.

Pain was the principal symptom noted in the series of cases. A mass and swelling were present in a few instances. Fibrous dysplasia occurred in 5 cases. Extracranial adamantinoma is a slow-growing epithelial tumor which occurs in bone. The origin of the epithelial tissue is unknown. No agreement has been reached as to whether the epithelial tumor is a basal cell or squamous cell carcinoma. There was no sex predominance.

The roentgenographic appearance of the lesion is

not diagnostic and varied considerably from case to case. In 19 cases the appearance was described as cystic or multicystic. Cortical expansion has been reported. Cortical destruction may occur. In 4 cases, periosteal reaction was present.

Microscopically, variations may include the following patterns: basal cells, adenocystic basal cells, squamous cells, an ameloblastic or a sarcomatoid pattern.

The treatment of choice, according to the authors, is amputation, preferably through the more proximal bone. They base their opinion on the fact that the tumor is almost certain to recur. In 17 of the 27 cases of the series, recurrence is known to have taken place, followed by death in 8 instances. Metastasis was proved by biopsy in 4 cases, which further emphasizes the necessity for radical surgical treatment. Recurrence after roentgen therapy or after a local surgical procedure is a prominent characteristic of the tumor.—*Ralph S. Bromer, M.D.*

Golding, J. S. R., and Sissons, H. A. Osteogenic fibroma of bone; a report of two cases. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 428–435.

The 2 cases which are reported in this article were found during a survey of bone lesions in which a diagnosis of osteoid osteoma had been suggested. The 2 cases were remarkably alike and although at first sight they appeared to belong to the osteoid osteoma group, on careful study it became evident that they differed from it both clinically and pathologically. In each case the symptom was paraplegia from cord compression by an expanding lesion originating in the region of the vertebral lamina, the lesions themselves causing little pain. Permanent recovery followed local excision of the tumors, although in each case roentgen therapy was instituted on the erroneous supposition that the lesions were malignant. Histopathological study of the resected tissue revealed in each case a mixture of osteoid tissue, irregularly calcified nonlamellar bone and cellular fibrous tissue. The lesions resembled closely those that Lichtenstein has called "osteogenic fibroma" of bone.

The lesions of the 2 cases reported showed a closer similarity to osteoid osteoma than to osteosarcoma or osteoclastoma. They did not cause the severe pain characteristic of osteoid osteoma. They were considerably larger, and showed progressive enlargement with compression of adjacent soft tissues. There was also an absence of a zone of sclerosis surrounding them which is found in osteoid osteoma. Pathologically, the cases consisted of the same tissue components—osteoid tissue and nonlamellar bone, osteoblasts and osteoclasts, and vascular fibrous tissue —but the proportions of each, and their arrangement were different. In particular, the continuous network of bone and osteoid tissue which makes up the "nidus" of osteoid osteoma was absent and there was much more fibrous tissue. The authors suggest the lesions represent a condition allied to, but usefully separated from osteoid osteoma of bone.—*Ralph S. Bromer, M.D.*

Sankaran, Balu. Osteoid osteoma. *Surg., Gynec. & Obst.*, Aug., 1954, *99*, 193–198.

Thirty-two cases of osteoid osteoma are reviewed from the New York Orthopedic Hospital of which 21 were pathologically confirmed.

The age ranged from nineteen months to thirty-three years (average 11.8 years). The bones of the lower extremities were involved in more than half of the cases (tibia in 15 cases, ilium in 3 cases, femur in 6 cases, humerus in 3 cases, metacarpals in 2 cases, metatarsals in 1 case, fibula in 1 case, phalanx of the toe in 1 case).

In 30 cases the predominant symptom was pain, usually at the site of the lesion, but in some was referred to the neighboring joint. In 2 cases painful limp was the presenting symptom. Tenderness. and swelling were the principal physical findings. Only 1 patient had an elevated sedimentation rate.

Almost all cases presented a classic picture of dense osteosclerosis with usually a centrally placed translucent zone varying from 2 to 15 mm. if symptoms had been of sufficient duration. If dense sclerosis was present, laminagrams were of value to demonstrate the nidus. Absence of osteosclerosis may be noted especially in the ilium.

Pathologically, the gross lesions showed dense sclerosis except in 2 instances, 1 in the ilium and 1 in the terminal phalanx. The nidus, at times, was so small that it was felt that if there was any doubt at the time of surgery of its removal, it would be of value to take roentgenograms in the operating room to assure removal. Failure of removal was believed to have happened in 8 of these cases. Microscopically there were usually a large number of mesenchymal cells scattered irregularly in the field with abundant osteoid tissue. At times, plasma cells, lymphocytes and foreign body giant cells with phagocytosed hemosiderin were found. In 1 case lymphocytic infiltration was found in an adjacent muscle biopsy.

Differential diagnosis included Garré's sclerosing osteomyelitis, Brodie's abscess, syphilitic osteitis, tuberculous osteomyelitis, fibrous dysplasia and eosinophilic granuloma.

Excision of the lesion is the only satisfactory cure. One case had a pathologic fracture after excision of too much thickened cortex and 1 developed intransigent ankle edema secondary to scar formation.—*George A. Miller, M.D.*

Dixon, Theodore F., Mulligan, Lily, Nassim, Reginald, and Stevenson, F. Harwood. Myositis ossificans progressiva; report of a case in which A.C.T.H. and cortisone

failed to prevent reossification after excision of ectopic bone. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 445–449.

Myositis ossificans progressiva is a rare disease. Strictly, the authors of this article state, it is misnamed for the essential pathological change is a metaplasia of connective tissue in and between muscles, leading to the progressive formation of embryonic connective tissue, adult connective tissue, cartilage and bone. Degeneration of muscle fibers and sarcolemmic proliferation follow; the bone formed may contain marrow and is not chemically different from ordinary bone. Sites of this metaplasia may be indicated first by localized, sometimes hemorrhagic swellings in muscle appearing spontaneously or after injury. Onset may be in the first year of life, is common in early childhood and rare after adolescence. If tendons are ossified the roentgenographic appearance may suggest diaphyseal aclasis. There is commonly an associated microdactyly affecting the great toes. The main sites of ossification are the muscles of the trunk, the masseters, and the upper arms; the neck and laryngeal muscles may also be involved. Excision of ectopic bone has usually been followed by recurrence. Death has commonly followed increasing rigidity leading to pneumonia or chronic sepsis from bed sores. The blood chemistry (including estimation of the serum alkaline phosphatase) has been previously reported as normal.

The case reported in this article is that of a girl, twelve years old at the time of investigation. Roentgenographic examination revealed no enlargement of the pituitary fossa. The neck showed a solid collar of bone extending from the occiput to about the level of the second and third thoracic vertebrae; there was a further smaller bar on the right side of the neck posteriorly. Congenital fusion of all the cervical vertebrae except the first and seventh was present. There were irregular masses of bone in both axillae and scapular regions. Around the knee joints were multiple slender exostoses. In the trunk a solid mass of bone extended downwards from the right lower thoracic region posteriorly, where it was attached to several ribs. It reached down to the level of the fourth lumbar vertebra. Additional smaller pieces of bone were present on the left side. There appeared to be partial fusion of the sacroiliac joints with a few small plaques of bone in the soft tissues; these were most marked around the neck of the left femur. Both femoral necks were deformed and the acetabula were shallow.

The biochemical investigations are given in detail in the article. Noted in the summary is the fact that serum of the patient showed an increased power of calcification of rachitic rat cartilage. Estimations of alkaline phosphatase showed slightly raised values.

Surgical removal of a bony bar was followed by prolonged administration of ACTH and cortisone, but no effect on the calcium-phosphorus balance or on the reossification within the area of operation was observed. The authors seem certain that in this case cortisone in the dosage given had no effect in retarding the process of reossification, which was manifest only nine weeks after excision of the bar of bone.—*Ralph S. Bromer, M.D.*

Irving, J., and Le Brun, H. Myositis ossificans in hemiplegia. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 440–441.

In this short report, a case is described of hemiplegia in a seventy-four year old woman due to cerebral hemorrhage in which myositis ossificans of the adductor muscles of the paralyzed hip developed rapidly and caused a swelling in the groin. The roentgenogram of the left hip area showed a very extensive myositis ossificans in the adductor region, with no obvious origin from the femur or pubis.

Localized myositis ossificans appears to have some connection with disease of the central nervous system, but the relationship is obscure. Heterotopic ossification has long been recognized in cases of traumatic paraplegia, and more recently it has been described in anterior poliomyelitis. The similarity between roentgenographic changes seen in myositis ossificans and those occurring in the soft tissues in the neighborhood of neuropathic joints has been emphasized by Brailsford. This led him to suggest that, in all cases of localized myositis ossificans following contusions, a lesion of the central nervous system might be present, even though it were only a transient vascular disturbance produced by the trauma.—*Ralph S. Bromer, M.D.*

Grogono, B. J. S. Injuries of the atlas and axis. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 397–410.

In this article, 8 cases of injuries to the atlas and axis are reported. The cases are grouped as follows: isolated fractures of the atlas; spontaneous dislocation of the atlas and axis; uncomplicated anterior fracture-dislocations; uncomplicated posterior fracture-dislocations; fracture-dislocations complicated by spinal cord injury.

The routine roentgenographic projections used in the cases reported were the anteroposterior and lateral. The exposures in the anteroposterior projection were made through the open mouth. Plain roentgenograms do not always exclude the possibility of subluxation of the atlas and axis. The distance between the anterior arch of the atlas and the odontoid process in adults has been measured at 2.5 mm. and in children it varied up to 4.5 mm. Special roentgenographic techniques such as laminagraphy, stereoscopic views and the use of contrast media may be necessary in the examination of these cases.

In the summary and conclusions, the author states that injuries to the atlas and axis may occur at any

age, and that they are usually not fatal. In children, spontaneous rotatory dislocation is the commonest type of lesion. In adults, fracture of the odontoid is more likely. The spinal cord is often undamaged. In some cases, complicated by cord damage, the neurological disturbance is caused by an associated injury to the lower cervical spine. Spinal cord damage may be immediate or delayed. In cases of incomplete cord lesion there may be recovery of function after reduction of the displacement or without such reduction. Though many patients would survive without treatment, the initial discomfort and danger of complications demand that adequate protection be provided. In relatively minor injuries and in old people, protection by a plaster collar may be sufficient. In some cases it is justifiable to undertake manipulation and apply a plaster. Cases with severe displacement require traction, preferably by skull calipers. Recurrent displacement, instability, and cord signs demand operative reduction and fusion. Satisfactory fusion of the atlas and axis is feasible, and good function is preserved. More extensive fusion of the cervical spine is seldom necessary.—*Ralph S. Bromer, M.D.*

Whiston, T. B., Fractures of the surgical neck of the humerus; a study in reduction. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 423–427.

Fractures of the surgical neck of the humerus are commonly grouped into adduction and abduction types, each the product of a definite mechanism, and each presenting a characteristic roentgenographic pattern. It is considered that a fall on the outstretched hand and the forcible adduction or abduction of the patient's arm following the moment of impact, according to the movement of the trunk, is the main sequence of events culminating in one or the other type of fracture.

The ordinary anteroposterior roentgenograms show the type of fracture, with or without impaction. The author feels, however, that such films can be deceptive, and in order to ascertain the full extent of the deformity, roentgenograms in additional views should be taken, namely, the lateral or transaxillary projection with the tube directed into the axilla of the abducted arm and the cassette placed above the shoulder. If pain prevents the assumption of this position without anesthesia, a transthoracic projection will disclose the true nature of the lesion, and complete the roentgenographic evidence. In 6 of the 7 cases reported in this article, the fractures were characterized by marked rotation of the humeral head and anterior displacement of the shaft, such deformity being fully demonstrated only in the transthoracic views. The ordinary posteroanterior projections gave little or no indication of the existence of the displacement and rotation. This displacement is usually difficult to reduce when reduction is attempted. Accurate reduction was obtained by the author using these projections.

The technique of reduction used by the author is described, and serial roentgenograms are reproduced, showing healing of the fractures and end results. He suggests that in young and active patients having fractures with typical gross displacement, in whom accurate reduction is desirable with a view to obtaining good recovery of function, his method should prove effective. A spica skillfully applied in the abducted and laterally rotated position is quite safe and soon relieves pain at the site of fracture.—*Ralph S. Bromer, M.D.*

Bossi, Renzo, and Pisani, Giovanni. Stippled epiphyses in a newborn infant without micromelia. *Brit. J. Radiol.*, Aug., 1954, *27*, 449–452.

Abnormal deposits of calcium in cartilaginous epiphyses and apophyses have been observed in newborn and infant children, sometimes long before the appearance of ossification centers. The stippled deposits are discovered roentgenographically. They occur only in bones having their origin in cartilage, the calcifications being usually situated in the periphery of the ossification nucleus.

The authors distinguish three types of deposits: (1) single scattered, well defined, rather regular densities simulating ossification centers; (2) numerous larger or smaller, often highly irregular densities occupying the greater part of the epiphysis, possibly surrounding a central ossification center; (3) cloudy densities occupying more or less of the cartilage.

Other clinical findings may be present, the most frequent of which is a shortening of the long bones of the limbs.

The authors review the conflicting evidence in the literature concerning the association of stippling with chondrodystrophy, and suggest that the two conditions are independent of one another but may be associated. They agree with Caffey that stippling is found in many patients without disproportion of skeletal elements, but may be associated with residual deformities and shortened stature in a typical chondrodystrophy.

They classify the cases in the literature in two distinct forms. The first, of greater severity, is found in the newborn or postnatal period. The patients are weak and fragile. Half die in the first year, but survival is the rule thereafter. The second form of the disease is a mild one, found usually by examination of relatives of patients in the first category, who exhibit no deformity whatsoever. Not fitting into either category, however, are 2 reported cases in the newborn with a poor prognosis, in which there is no shortening of the limbs. The authors report a third such case, in a premature fetus (seven months) who died "in a very short space of time" after a forceps delivery. Physical and serological examina-

tions were normal. Roentgenograms showed much scattered well defined calcified stippling of the epiphyses of the lower extremities only. There were no alterations of a chondrodystrophic nature.—*E. C. Davis, M.D.*

Jones, G. Blundell. Paralytic dislocation of the hip. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 375–384.

Paralytic dislocation of the hip deserves recognition as a special problem. It should not be grouped, according to the author, with other types of pathological dislocation. In this article twenty-two dislocations of the hip, occurring in patients paralyzed from an early age, are reviewed. All showed abnormal coxa valga. The coxa valga which may gradually reach 180 degrees, precedes dislocation and makes it inevitable. The presence of unbalanced abductor power may hasten dislocation, but the latter can occur in complete flaccid paralysis. The femoral head progressively rides out of the acetabulum and the subsequent growth of the femoral neck may bring it into alignment with the femoral shaft or even beyond. The empty acetabulum, although gradually becoming more shallow, remains of useful depth for several years. When the dislocation is beginning, it can be reduced easily by simple abduction. In the later stages a contracture of the capsule and of the iliopsoas muscle appears, so that after four or five more years it becomes irreducible by traction or manipulation.

The combination of structural instability of the hip joint and muscular weakness may make independent walking impossible, but the restoration of stability gives considerable improvement in any remaining muscular power and may alter the patient's whole future. The results of 9 operations are described. Corrective osteotomy below the femoral neck with internal fixation was employed for those cases in which reduction of the hip dislocation can be obtained by simple adduction. Open reduction, wedge osteotomy below the femoral neck, femoral shortening and internal fixation were employed for the late cases with contracture, in which the dislocation was irreducible even after a period of strong traction and gradual abduction with adductor tenotomy.—*Ralph S. Bromer, M.D.*

Weissman, S. L. Congenital dysplasia of the hip; observations on the "normal" joint in cases of unilateral disease. *J. Bone & Joint Surg.*, Aug., 1954, *36-B*, 385–396.

There is but one feature in congenital dysplasia of the hip which seems to have escaped notice, namely, the condition of the opposite hip in cases of unilateral dysplasia. While examining infants with signs of unilateral preluxation, the author was impressed by the persistent abduction attitude assumed by the opposite hip. The examination of 51 infants presenting signs of unilateral dysplasia of the hip disclosed the existence of an abduction-contracture in the opposite "normal" hip. The abduction-contracture was not infrequently found in the newborn, but seemed to attract attention mostly between the second and fifth month of life. It was seldom found after the sixth month. The dysplasia in the contralateral hip showed the usual features. The relationship between the degree of abduction-contracture and the degree of dysplasia was a direct one only occasionally. In most cases they seemed unrelated to each other.

Observation of these patients showed that the abduction-contracture followed a constant course towards gradual and spontaneous regression. The dysplasia progressed in one of the following ways: spontaneous recovery, rapid or slow recovery with treatment by abduction splint, subluxation or true dislocation. It is suggested by the author that the coexistence of unilateral dysplasia of the hip and abduction-contracture in the opposite hip is not fortuitous. He believes that the fixed obliquity of the pelvis which leads to the upward and lateral displacement of the femoral head and the stretching of the abductors produces the fundamental features of the dysplasia in the hip opposite the contracture. He concludes that the discovery of unilateral abduction-contracture soon after birth should be a warning that dysplasia may develop in the opposite hip. A careful watch should therefore be kept for signs of abduction-contracture and for later development of dysplasia.—*Ralph S. Bromer, M.D.*

Sagrera, J. M. Metastasis en la rótula de un hipernefroma. (Metastasis in the patella from hypernephroma.) *Acta iber. radiol. cancerol.*, July–Sept., 1954, *3*, 363–367.

Metastases from hypernephroma are very frequently found in the lung, liver and skeleton. The patella is an exceptionally rare location. This metastasis developed fourteen months after surgical intervention for hypernephroma; later another one appeared in the left hip, and finally pulmonary metastases developed.

Under roentgen therapy the metastases in the bones followed a favorable course, the patient being able to continue his ordinary work until fifteen days before death.—*James T. Case, M.D.*

Coonrad, Ralph W., and Bugg, Everett I., Jr. Trapping of the posterior tibial tendon and interposition of soft tissue in severe fractures about the ankle joint. *J. Bone & Joint Surg.*, July, 1954, *36-A*, 744–750.

Two cases of trapping of the posterior tibial tendon, in which there was associated trapping of the posterior tibial nerve, and 2 cases with interposition of a reflected portion of the deltoid ligament within the medial aspect of the joint space are reported in

this article. These are presented as complications of severe fracture-dislocation of the ankle joint, requiring open reduction. Failure to achieve anatomical reduction in fractures about the ankle joint is probably the greatest cause of poor end results.

This is all too often due to one of the following reasons: (1) a tendency on the part of many to be satisfied with "an almost satisfactory" reduction, (2) insufficient courage to tell the patient that a second or third manipulation may be necessary, (3) a desire to spare the patient additional anesthesia, and (4) failure to obtain roentgenograms made in true anteroposterior and lateral planes. Roentgenograms which are not made in such planes can well be misleading in evaluation of mortise alignment.

The authors suggest that any patient with fracture-dislocation in which severe ligamentous injury and disruption of the mortise is present, and which cannot be reduced by initial closed manipulation, should be considered a candidate for early open surgical reduction.—*Ralph S. Bromer, M.D.*

Blood and Lymph System

Levin, Bertram, and Borden, Craig W. Anomalous pulmonary venous drainage into the left vertical vein. *Radiology*, Sept., 1954, *63*, 317–324.

Four cases of anomalous drainage of the pulmonary veins into the left vertical vein are presented. This vein is a wider vascular structure to the left of and adjacent to the base of the heart, linking the pulmonary veins and the left innominate vein. The authors point out the characteristic roentgen features of this anomaly and stress the need for its recognition, since some cases may be surgically correctable.

The cardiac silhouettes in these cases, as well as in 10 other cases in the literature, were similar in that they were likened to a figure 8. The upper loop of the figure 8 is made up of the dilated superior vena cava and of the anomalous left vertical vein; the lower loop is formed by the heart. The left cardiac chambers are usually small as compared to the greatly enlarged right heart. Differential diagnosis of other causes of upper mediastinal widening is usually not difficult when all findings in a given case are considered. Angiocardiography may be useful, not only for visualization and identification of the left vertical vein, but also to show evidence of a large shunt into the innominate vein and superior vena cava.

Clinically, symptoms may be mild in the case of partial pulmonary venous return via the anomalous route with no major intracardiac abnormalities. If the shunt is large, a history similar to interatrial septal defect may occur. The clinical features are not diagnostic but, in the presence of the typical roentgenological findings, they are quite suggestive. Definitive diagnosis requires cardiac catheterization with recovery of blood and a high oxygen saturation directly from the left vertical vein or at its junction with the innominate vein.—*Michael J. Healy, M.D.*

Du Boulay, G. H., and Green, B. Portal venography in Banti's disease. *Brit. J. Radiol.*, Aug., 1954, *27*, 423–434.

Venography is carried out to determine if the portal vein is long enough and large enough to anastomose to the inferior vena cava in cases of clinically diagnosed portal hypertension. This series of cases is presented to show that at laparotomy portal venography provides the surgeon with all the information he needs more safely than does the splenic puncture.

Whipple in 1945 classified portal hypertension into (a) intrahepatic block in cirrhosis, and (b) extrahepatic block of 2 types: (1) replacement of portal vein by scar tissue with little or no recanalization, and (2) transformation of the portal vein or its main branches into a cavernomatous mass.

Portal venography was carried out on a total of 46 patients. Intra- and extrahepatic obstructions to the portal venous system, due to cirrhosis of the liver, portal vein anomalies, extrinsic pressure on the portal vein, or venous thrombosis, were demonstrated. All but 2 patients had portal hypertension. Seventeen had cirrhosis, 10 had cavernomatous replacement of the portal vein, 3 had large thrombi of the portal vein, 1 had stricture of the portal vein, 1 showed pressure from a cirrhotic nodule, 1 had obstruction from carcinoma, 2 had excessive formation of collateral vessels around pancreas, and a few had portal hypertension without obstruction associated with large spleens due to Gaucher's disease and primary anemia.

Technical failures not included in the authors' series resulted from: (1) insufficient exposure; (2) insufficient contrast medium; and (3) failure of the anesthetist to stop the patient's breathing.

In four-fifths of the cases the portal vein was shown to be suitable for anastomosis with the vena cava. The main value of the procedure, in the authors' opinion, has been to demonstrate veins which are usable for anastomosis. Gastric varices have been found when esophageal varices were not demonstrable.

The authors consider the use of portal venography at laparotomy to be preferable to percutaneous injection of the opaque medium by splenic puncture which is apt to be dangerous unless facilities are available for immediate laparotomy.—*E. C. Davis, M.D.*

Leroux, G. F., and de Scoville, A. Splénoportographie transpariétale. (Transparietal splenoportography.) *J. belge de radiol.*, 1954, *37*, 89–137.

In the introduction of this article the authors

give the history of the comparatively recent method of splenoportography with accompanying references to the relevant publications. The different methods for roentgenological examination and visualization of the splenic vein, the portal vein and the hepatic veins are described. The importance of these methods as preoperative procedures is stressed.

Before using transparietal splenoportography on man the authors made experimental investigations on animals with the goal of proving the innocuousness of the injection of iodine salt solutions into the spleen. In dogs of not more than 7 to 9 kg. in weight a laparotomy was performed, and two small liver fragments were taken for histological examination with two different staining methods. Subsequently 1 or 2 cc. respectively of a 70 per cent umbradil solution per kg. body weight was injected into the spleen. Seriograms with the Fairchild camera were made at intervals of 0.6 seconds. The finished seriograms showed progressive visualization of the splenic vein, the portal vein and the right and left hepatic veins with no time difference of appearance of left and right hepatograms.

The dose of 2 cc. per kg. body weight which provided the best visualization of the veins was found to be completely innocuous even though in some animals the phlebographies were repeated three or four times. Histological examinations did not show any liver damage, such as hepatitis or cirrhosis. Macroscopic examination of the spleen at every laparotomy revealed only minimal fibrotic reaction around the hemorrhage, corresponding to the passage of the needle.

After these experimental studies, which indicated a permissible dose of 140 cc. of the 70 per cent umbradil solution in an adult man, the authors began their clinical studies with the following technique: On preparing the patient for splenoportography, blood clotting tests, aspiration of ascites if present, and allergy tests were made. For the latter they injected 0.1 cc. of umbradil solution intracutaneously and 1 cc. of umbradil intravenously. The patient, after administration of morphine, was placed on the roentgenographic table. The spleen was outlined by palpation and percussion. In small spleens which could not be outlined by either method vertical puncture in the eighth or ninth anterior intercostal space, in a zone 4 cm. from the lateral chest wall, was performed. Following novocaine infiltration of the puncture area, a needle of 16 cm. length was pushed into the spleen in vertical direction. After removal of the stilet, usually followed by outflow of a few droplets of blood, they injected 3 to 4 cc. of saline solution to prevent any clogging of the needle.

On the first few cases they performed the injection under fluoroscopic control. After injection of 4 to 5 cc. of umbradil, which was sufficient to visualize the splenic vein, they injected within four seconds an additional 25 to 35 cc. The first exposure was made immediately at the start of the injection. Altogether seven roentgenograms of 30 by 40 cm. were taken with a seriograph devised by one of the authors (Leroux). The time interval between the single seriograms was 1½ to 2 seconds. As opaque media umbradil or a special iodine salt in 70 per cent solution was used.

The article is based on 19 cases in which splenoportography was performed. In 3 of these cases the roentgenographic findings were compared with the autopsy findings. In 3 cases splenoportography was performed postmortem.

All patients suffering from either cancer of the stomach, pancreas, liver and bileducts or cirrhosis of the liver were seriously ill and mostly precachectic. The splenoportography furnished valuable diagnostic information without any harmful side effects. Several roentgenograms demonstrated satisfactorily the extrahepatic splenoportal trunk and its deformations by tumors of pancreas, stomach or biliary tract. Three cases are reported in which thrombosis of the splenic vein was diagnosed from the roentgenograms.

In a special paragraph the authors discuss the importance of hepatography for the detection of liver metastases and liver cirrhosis.

In concluding, they emphasize the necessity of seriograms instead of single roentgenograms in splenoportography. Excellent reproductions of the seriograms accompany the case reports.—*Hans Lewin, M.D.*

Namin, Pierre. Percutaneous vertebral angiography. *J. Neurosurg.*, Sept., 1954, *11*, 442–457.

The author describes two methods of approach to the vertebral artery. One is from the anterolateral region of the neck, where the artery must be punctured between two transverse processes, generally between C-5 and C-6, or between C-4 and C-5. The other approach, preferred by the author, is at the base of the cranium. Here the artery has left the transverse passage in the atlas, and is directed a little posteriorly and medially to come in contact with the superior face of the posterior arch of the atlas. The author prefers this approach as it is less perpendicular to the artery, and therefore easier to accomplish. At this level the artery is not accompanied by the vein, while at the lower level the vein is lateral to the artery. A detailed description of both techniques is given, as well as the roentgenological technique.

Reproductions of a number of arteriograms are included, illustrating vascular malformations, tumors in the angle, supra- and retrosellar tumors, meningioma of the tentorium, thrombosis of the posterior cerebral artery, and thrombosis of the right internal carotid artery.

The author does not consider the procedure as

dangerous, if one follows the proper indications and observes certain rules. Four accidents were reported, 2 of them fatal, out of 160 angiographies. Three of the 4 accidents, including the 2 fatalities, are considered preventable. Contraindications are the same as for carotid angiography, and include hypertension, renal insufficiency, and diffuse vascular sclerosis of those with coronary disease. Asthma should make one fear allergic reactions to iodized products. —*D. S. Kellogg, M.D.*

Josselson, A. J., and Kaplan, Joseph H. Fatal reaction following aortography with neo-iopax. *J. Urol.*, Aug., 1954, *72*, 256–260.

The authors present the case of a thirty-five year old white female whose initial complaints were palpitation and morning headaches. The physical examination revealed a blood pressure of 190/120 mm. Hg, known to have been present for at least nine months, although the patient stated she was told her blood pressure was "slightly" elevated twelve years ago during pregnancy. The ocular fundi revealed moderately diffuse arteriolar sclerosis with no hemorrhages or exudates and nothing abnormal in the optic disks. Roentgenogram of the chest was negative. Blood nonprotein nitrogen, complete blood count, blood serology, serum calcium and serum phosphorus were all within normal limits. The serum albumin was 3.6 gm. per 100 cc. and the serum globulin was 3.4 gm. The urinalysis revealed specific gravities of 1.008 and 1.009 and showed albumin ranging from a trace to +2. An excretory urogram using 20 cc. of 50 per cent neo-iopax revealed no visualization of the left kidney with a 1.2 cm. calculus present at the ureterovesical junction. Compensatory hypertrophy of the right kidney was also noted. Removal of the left kidney was contemplated, and in order to estimate the circulatory status of that kidney, an aortogram using 15 cc. of a 75 per cent solution of neo-iopax was done. This showed practically no circulation in the left kidney and adequate circulation in the right kidney. The procedure produced no ill effects at that time.

Five days after the aortography, the patient was hospitalized because of persisting nausea, vomiting and ileus. The temperature ranged from 100 to 101° F. Laboratory tests revealed mild anemia, a nonprotein nitrogen of 120 mg. per cent and a bleeding time of twenty-one minutes. All serum electrolytes were normal. The urine became grossly bloody and the output averaged about 200 to 500 cc. per day. The patient failed to respond to any treatment and the nonprotein nitrogen rose to 580 mg. per cent. A diffuse petechial rash appeared, a uremic pericarditis developed and the patient died shortly thereafter.

At necropsy, the lungs weighed 800 gm. and there was 1,500 cc. of blood-tinged fluid in the left pleural cavity and 1,000 cc. in the right pleural cavity. There was evidence of partial atelectasis in both lower lobes. The heart weighed 375 g. and there was marked left ventricular hypertrophy. The pericardial sac contained 500 cc. of bloody fluid and there was fibrinous exudate on both the pericardial and epicardial surfaces. The left kidney was shrunken and nodular measuring 6 by 4 by 3 cm., and showed a solitary cyst 12 mm. in diameter; on opening it, there was marked dilatation of the calyces and pelvis with a parenchyma measuring only 5 mm. in thickness. The left ureterovesical junction contained a 1.2 by 0.8 cm. calculus completely obstructing the ureteral ostium. The right kidney measured 15 by 8 by 7 cm. and numerous cortical abscesses were evident; on section numerous small areas of hemorrhage and cortical abscess formation were seen.

Microscopically, the left kidney showed evidence of severe chronic pyelonephritis; the right kidney showed multiple small abscesses, intimal fibrosis of arterioles and small arteries, and various stages of tubular degeneration. In the proximal convoluted tubules there was evidence of desquamation and regeneration on the lining epithelium.

The authors feel that this case shows an instance of severe renal impairment of one kidney with only moderate impairment of the other until renal failure was produced by an added insult of the neo-iopax used as the contrast medium for aortography. Many of the postmortem changes were consistent with heavy metal poisoning of the kidney due to its inability to excrete iodine adequately.—*Olin S. Allen, II, M.D.*

General

Boyd, Joseph A., Patrick, Simmons I., and Reeves, Robert J. Roentgen changes observed in generalized scleroderma; report of sixty-three cases. *A.M.A. Arch. Int. Med.*, Aug., 1954, *94*, 248–258.

The authors report the roentgen changes observed in 63 cases of generalized scleroderma studied in the Department of Radiology at the Duke University School of Medicine. Of the 63 cases, 57 had one or more roentgen examinations. Forty-five of the patients studied roentgenologically had one or more of the roentgenologic abnormalities which have been previously reported in connection with this disease. Most of the patients were white females between the ages of thirty and fifty years.

The collagen disorder is characteristically associated with vascular abnormalities, endarteritis, arteriolonecrosis and lesions resembling periarteritis. There are clinical and roentgenologic manifestations of scleroderma in practically all of the major systems of the body. Sixty of the 63 patients had evidence of soft tissue or vascular changes in the hands.

The lungs were examined in 54 patients. Abnormalities were found in 44 per cent. Thirty-one

patients had roentgenograms of the bone with a positive yield of 59 per cent. The gastrointestinal tract was examined in 29 patients and abnormalities were found in 79 per cent of this group. The authors also indicate the high incidence of abnormal roentgenologic findings in soft tissues, joints, the hematopoietic system and the heart.

Attention is called to the fact that there is a high incidence of positive roentgen findings in generalized scleroderma. This incidence would probably be even higher if all patients were more extensively studied.—*C. L. Hinkel, M.D.*

Abrams, Herbert L., Carnes, William H., and Eaton, John. Alimentary tract in disseminated scleroderma with emphasis on small bowel. *A.M.A. Arch. Int. Med.*, July, 1954, *94*, 61–81.

The authors (Stanford University School of Medicine) review the literature dealing with the manifestations of scleroderma in the small intestine and they report 6 cases of their own in detail. After a summation of manifestations of the disease in the bones, joints, soft tissues, and esophagus, the authors proceed to describe and to illustrate the characteristic changes seen roentgenologically in study of the small intestine.

The most characteristic roentgen change in the small intestine was marked dilatation. This was usually seen in the second or third portions of the duodenum and in the jejunum. It was seen less frequently in the distal portion of the small intestine. At times, the small bowel loops were increased to 5 cm. or more in diameter, suggesting organic intestinal obstruction or ileus. Hypomotility was usually marked, even in the presence of profuse diarrhea. In spite of the gross abnormalities, there was usually no segmentation of the barium or loss of mucosal pattern.

Attention is called to the fact that in this disease intestinal symptoms may develop rapidly and may be so severe as to result in early death. Three of the authors' patients succumbed to the disease and autopsy findings are included. The small bowel changes are believed to result from intrinsic collagen deposition in the intestine, resulting in adynamic local dilatation. Because of a flat glucose tolerance curve, it is suggested that small intestinal absorption is deficient.

Cortisone produced dramatic, subjective and objective improvement in one patient, but it failed in another. A third patient could not be treated adequately because of the development of a psychosis.—*C. L. Hinkel, M.D.*

RADIATION THERAPY

Hammer, G., Hiller, J., and Jakob, A. Ein Beitrag zur Begutachtung des sogenannten chronischen Strahlenschadens. (A contribution to the expert evaluation of the so-called chronic radiation damage.) *Strahlentherapie*, 1954, *94*, 64–71.

Changes in the blood picture that result from radiation damage are of two types: (1) Small doses repeated over a long period of time produce slight depression of the bone marrow resulting in leukopenia. (2) Larger doses cause cessation of blood formation, panmyelophthisis, with aplastic anemia.

Insofar as chronic radiation injury is concerned, the presence of leukopenia is not enough to permit an expert to testify that radiation damage has occurred. Perhaps if additional evidence of radiation damage exists—changes in the skin or gonads—leukopenia can be presumed to be due to radiation. Otherwise (1) previous overexposure to radiation must be proven; (2) the hematologic changes must bear the correct time relationship to the radiation exposures, and (3) the peripheral blood must show the characteristic cycle of changes: neutrocytosis, then neutropenia and lymphocytosis, then lymphopenia, with the lymphocytic lagging behind the neutrophilic variations.—*Henry G. Moehring, M.D.*

Petersen, Olaf, Radiation cancer; report of 21 cases. *Acta radiol.*, Sept., 1954, *42*, 221–236.

Twenty-one cases are presented bearing irrefutable evidence of the carcinogenic effect of ionizing radiation. The historical literature on this subject is thoroughly reviewed, there having been but about 200 previously reported cases. The majority of the early cases were termed "occupational radiation cancer," while most of those in this study were due to therapeutic irradiation.

The latent period, from the beginning of irradiation to the onset of the cancer, ranged from two to forty-two years in this series, with an average of 27.5 years. Unfortunately, the dosage and quality of irradiation are unknown in many of the cases, and all treatment was started and finished before Coutard introduced the protracted fractionated method. Histologic examination revealed prickle cell carcinoma in 11 cases, basal cell carcinoma in 8, and fibrosarcoma in 2. All of the original lesions irradiated were of a benign nature. All of the cancers developed in areas of "chronic atrophic roentgen dermatitis." There was no constant relationship between the severity of the radiation reaction and the latent period. Four of the cancers developed in sites previously treated with radium.

Surgical excision was used in most instances, roentgen contact therapy being employed in only 2 cases successfully. No cases of regional extension or distant metastases were found. Ten of the patients showed no signs of recurrence from four to eighteen years after treatment. Four other more recent cases are alive without recurrence. The remaining 7 either succumbed to cancer or died of operative complications.—*Arch H. Hall, M.D.*

Arnold, Arthur. Effects of x-irradiation on the hypothalamus: a possible explanation for the therapeutic benefits following x-irradiation of the hypophysial region for pituitary dysfunction. *J. Clin. Endocrinol. & Metabol.*, Aug., 1954, *14*, 859–868.

During a period of four years, observations have been made in an analysis of the effects of high energy roentgen rays on the central nervous system of the monkey and man. These 23 mev. roentgen rays were generated with the medical betatron at the University of Illinois.

It was noted that the paraventricular and supraoptic nuclei of the hypothalamus are readily identifiable cellular aggregates. It was also observed that a deficit of cells and degenerative changes in the surviving cells occurred five to six months following irradiation of the hypothalamus area in monkeys. These changes were seen after tissue doses of 1,500–7,000 r were administered.

It has been generally thought that the hypophysis is normally resistant to irradiation, due largely to the lack of histopathological changes. Functional alterations, however, have been observed. Since irradiation of the pituitary region usually exposes the ventral portion of the hypothalamus, and the pituitary is under at least partial neural control of the hypothalamus, the observed effects on cells in these hypothalamic nuclei may explain in part the beneficial clinical effects of pituitary irradiation for such conditions as malignant exophthalmos, certain cases of hypertension and various functional gynecologic conditions.

The work of Beierwaltes in treating malignant exophthalmos with roentgen irradiation to the region of the hypophysis is interesting since beginning recession was seen in three months and maximum recession was noted in an average of 11.8 months after irradiation. These intervals compare with the five to six month period cited by the author.

Technical factors are presented in detail. Illustrative photomicrographs excellently demonstrate the cytological changes described.—*K. L. Krabbenhoft, M.D.*

Gedda, Per Olof, and Lindgren, Martin. Pituitary and orbital roentgen therapy in the hyperophthalmopathic type of Graves' disease. *Acta radiol.*, Sept., 1954, *42*, 211–220.

Graves' disease may be classified into three types with respect to ocular manifestations:

I. Thyrotoxicosis without ophthalmopathy.
II. Thyrotoxicosis with ophthalmopathy (classic).
III. Hyperophthalmopathic type with hyper-, eu-, or hypothyroid function.

The classic and the hyperophthalmopathic types may be differentiated clinically. The former is characterized by stare and muscular tension, lid retraction and lag, less lid bulging with typical folds exaggerated by weight loss, soft cushion effect with applied global pressure showing no increase in orbital tension, and no diplopia with little if any extraocular weakness. In contradistinction, the hyperophthalmopathic variety exhibits true forward displacement of the globe, lacrimation, photophobia, chemosis, gritty sensation in eyes, bulging lids, increased orbital tension with resistance to applied pressure, and frequent diplopia with extraocular muscle weakness or paralysis. The acute phase is characterized by edema and round cell infiltration of the retrobulbar fatty and connective tissue and eye muscles. In the chronic phase connective tissue proliferation and fibrosis produce an irreversible true exophthalmus.

The authors review the evidence ascribing the etiology of the hyperophthalmopathic type to the increased production of thyroid stimulating hormone (T.S.H.), and they caution that any intervention performed for the purpose of suppressing thyroid function is contraindicated inasmuch as thyroid tissue suppresses T.S.H. production.

A report of results of roentgen therapy to the pituitary and posterior orbital areas of 19 patients with Type III Graves' disease is given. In general, a depth dose of 3,000 to 4,000 r was given in sixty to ninety days. Satisfactory regression of eye symptoms occurred in most of the patients. Suppression of pituitary thyrotropic activity was shown by the fact that the irradiation controlled hyperactivity of the thyroid in all of the 10 patients with hyperthyroidism. Other hypophyseal functions were not affected by this amount of irradiation.

In view of the anatomic relationship between the orbits and the sella turcica, skull phantom measurements of depth dose were made which proved that the posterior orbital areas received roughly the same dose as the hypophysis. Thus the regression of eye symptoms may be ascribed at least partly to direct irradiation.

The authors stress the necessity of starting irradiation as early as possible before irreversible changes in retrobulbar tissue have occurred.—*Arch H. Hall, M.D.*